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NOTICES

1. *Annual Meeting:* University of Illinois, Urbana-Champaign, Ill.; January, 1920.
2. *Sections and Committees:* Chairmen are requested to be active in starting work and to keep in touch with the work.
3. *New Members:* They can be elected at any time. For application blanks apply to the secretary.
4. *Advertisements:* Examine these 65 pages relative to engineering and construction materials and supplies. Use them when wanting materials, prices and information. In writing to advertisers please state that you have seen their advertisements in the "Proceedings" of the Illinois Society of Engineers.

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Aff. Stahl, C. B., Gen. Mgr., White Hall Sewer Pipe & Stoneware Co. --------------------------------White Hall, Ill.
MEM. Stanfield, A. C., Civil Engineer--------------------Pana, Ill.
Aff. Sternberg, F. D., Manager, Carmichael Gravel Co.----------
-- Williamsport, Ind.
MEM. Stevens, Hubert A., City Engineer ---------------------
----------------------------City Hall, Corpus Christi, Texas
MEM. Stewart, John T., Lieut. Col. of Engineers, U. S. Army----
----------------------------2223 Knapp St., St. Paul, Minn.
MEM. Stickney, G. W., Civil Engr., C. & N. W. R. R.------------
-------------------------226 W. Jackson Blvd., Chicago, Ill.
MEM. Stinson, Ira S., (23rd Engineers, U. S. Army)----------
------------------------312 W. Church St., Champaign, Ill.
MEM. Studer, Wm. H., Civil Engr. and Surveyor-----Libertyville, Ill.
MEM. Sullivan, John M., Civil Engineer, Asst. Manager of Sales, Whitaker-Glessner Co.----2547 Arthington St., Chicago, Ill.
MEM. Talbot, Arthur N., Prof. of Municipal and Sanitary Eng'g., University of Illinois-------------------------Urbana, Ill.
MEM. Tarrant, Fred, District Engr., State Division of Highways
------------------------539 S. W. Grand St., Springfield, Ill.
MEM. Thomas, David O., Co. Supt. of Highways---------------
---------------------------------Court House, Belleville, Ill.
MEM. Thomes, Edward C., U. S. Drainage Engineer-------------
------------------321 Southern Trust Bldg., Little Rock, Ark.
Aff. Ticknor, Frank A., Attorney (Drainage Districts)--------
----------------------------124 So. Main St., Rockford, Ill.
MEM. Tobin, Edward J., City Engineer------------------Lincoln, Ill.
MEM. Tratman, E. E. R., Civil Engineer, Western Editor "Engineering News-Record" (Chicago)--------------Wheaton, Ill.
MEM. Trow, Linden C., Hydraulic Engr., Supt. Lake Forest Water Co.---------------------------------Box 181 Lake Forest, Ill.
MEM. Tryon, Charles L., Civ. and Drainage Engr., Co. Supt. of Highways--------------------511 Bunker St., Woodstock, Ill.
MEM. Waddell, J. V., Civ. Engr., Co. Supt. of Highways----------
--- Vandalia, Ill.
MEM. Wagner, H. F., Designing Engr., Ill. Traction System------
------------------------------315 Mayer Bldg., Peoria, Ill.
Aff. Walcott, E. L., Vice-Pres., Pacific Flush Tank Co.----------
------------------------4241 Ravenswood Ave., Chicago, Ill.
Aff. Wallace, R. W., Paving Promoter, Universal Portland Cement Co.----------------5965 Magnolia Ave., Chicago, Ill.
Aff. Warren, G. E., Div. Engr., Promotion Bureau, Universal Portland Cement Co.----1528, 208 So. LaSalle St., Chicago, Ill.
MEM. Warren, W. D. P., Civil Engr., Vice-Pres., Miller, Holbrook & Warren Co., Millikin Bldg.-----------------Decatur Ill.
Aff. Waterbury, A. D., Plumbing and Heating-----------------
----------------------------------P. O. Box 400, Polo, Ill.
MEM. Waters, Charles M., U. S. Asst. Engr., Ill & Miss. Canal--
--Wyanet, Ill.
MEM. Webster, Arthur L., Drainage Engineer, Co. Surveyor----
---------------------------------Court House, Wheaton, Ill.

MEM. WEBSTER, EDWIN R., Civil Engineer and Surveyor .... 327 So. LaSalle St., Chicago, Ill.
MEM. WELLS, E. ROY, Co. Surveyor, Pres., Wells Engineering Co. .... 344 Coulter Block, Aurora, Ill.
Aff. WHITNEY, W. P., Sales Manager .... P. O. Box 403, Springfield, Ill.
MEM. WILLIAMS, LAWRENCE H., Civil and Topographic Engineer, Y. M. C. A. Bldg. .... Quincy, Ill.
MEM. WILLIAMS, ROBERT E., Civil and Municipal Engineer .... 177 Gale Ave., River Forest, Ill.
MEM. WILSON, PAUL B., City Engineer .... 1st Nat. Bank Bldg., Marion, Ill.
MEM. WINDES, FRANK A., Civ. Engr., Village Engineer .... 958 Birch St., Winnetka, Ill.
MEM. WITHINGTON, JOSEPH, Surveyor (retired)* .... 1519 Broadway, Mattoon, Ill.
MEM. WOLFE, JONN W., Div. Engr., Bd. of Local Impts. .... 5525 So. LaSalle St., Chicago, Ill.
Aff. WOLFNER, IRA, Plant Manager, Nat. Cooperage & Woodenware Co. .... 2409 So. Washington St., Peoria, Ill.
MEM. WOLTMANN, J. J., Civil Engineer .... Nokomis, Ill.
Aff. WOOLLEY, GUY G., Road Promoter .... 1537 Conway Bldg., Chicago, Ill.
MEM. YAW, HOMER J., Asst. City Engr., Co. Surv. .... City Hall, Belvidere, Ill.

*Note.—The Executive Board in 1918 voted to remit all dues of Mr. Joseph Withington, retired. He has been a surveyor since 1857; is a veteran (Captain) of the Civil War, and has been a member of the Society since 1888.

SUMMARY OF MEMBERSHIP

Number on May 31, 1918		252
New members—June-December, 1918		0
Number on December 31, 1918		252
New members at annual meeting, 1919		16
New members—February-May, 1919		21
Total		289
Deceased: (J. L. Clark, J. I. Dappert, B. B. Gordon, H. L. Wells, C. W. Andrews)	5	
Resigned	7	
Dropped for two years non-payment of dues	20	
Total loss in 1918		32
Number of members on May 31, 1919		257

Members, 223. Affiliated Members, 34.

LIST OF ADVERTISERS

ILLINOIS SOCIETY OF ENGINEERS

List of Officers and Place of Meeting

1886--1919

Year	No. of Members	President	Vice-President	Secretary Ex—Executive R—Recording	Place of Meeting
1886	42	I. O. Baker	D. Gordon	A. N. Talbot, Ex. S. A. Bullard, R.	Univ. of Ill.
1887	54	I. O. Baker	J. T. Foster	A. N. Talbot, Ex. S. A. Bullard, R.	Univ. of Ill.
1888	81	C. G. Elliott	D. W. Mead	A. N. Talbot, Ex. S. A. Bullard, R.	Springfield
1889	87	C. G. Elliott	D. W. Mead	A. N. Talbot, Ex. S. A. Bullard, R.	Bloomington
1890	95	A. N. Talbot	D. L. Braucher	S. A. Bullard, Ex. S. F. Balcom, R.	Peoria
1891	102	A. N. Talbot	J. L. Clark	S. A. Bullard, Ex. C. M. Rickard, R.	Springfield
1892	116	S. S. Greeley	D. J. Stanford	S. A. Bullard, Ex. C. M. Rickard, R.	Chicago
1893	116	S. S. Greeley	G. F. Wightman	S. A. Bullard, Ex. Allen Enos, R.	Springfield
1894	87	D. W. Mead	T. S. McClanahan	J. A. Harman, Ex. W. D. Pence, R.	Univ. of Ill.
1895	109	D. W. Mead	P. C. Knight	J. A. Harman, Ex. J. E. Miller, R.	Monmouth
1896	118	C. C. Stowell	J. H. Burnham	J. A. Harman, Ex. J. W. Alvord, R.	Galesburg
1897	116	C. C. Stowell	E. J. Chamberlain	J. A. Harman, Ex. P. C. Knight, R.	Springfield
1898	118	A. D. Thompson	W. A. Darling	J. A. Harman, Ex. J. C. Quade, R.	Peoria
1899	111	A. D. Thompson	G. W. Chandler	J. A. Harman	Univ. of Ill.
1900	119	C. C. Brown	H. G. Paddock	M. S. Ketchum	Moline
1901	116	H. G. Paddock	Emil Rudolph	A. L. Kuehn	Bloomington
1902	119	H. G. Paddock	E. E. R. Tratman	A. L. Kuehn	Joliet
1903	122	J. W. Alvord	J. C. Quade	E. E. R. Tratman	Aurora
1904	133	J. W. Alvord	C. H. Nicolet	E. E. R. Tratman	Univ. of Ill
1905	155	D. H. Maury	J. G. Melluish	E. E. R. Tratman	Chicago
1906	177	D. H. Maury	E. Main	E. E. R. Tratman	Rockford
1907	195	C. B. Burdick	A. N. Johnson	E. E. R. Tratman	Peoria
1908	208	C. B. Burdick	F. W. Honens	E. E. R. Tratman	Univ. of Ill.
1909	225	J. B. Hittell	J. W. Woermann	E. E. R. Tratman	Chicago
1910	226	A. N. Johnson	J. W. Dappert	E. E. R. Tratman	Cairo
1911	230	J. G. Gabelman	J. A. Harman	E. E. R. Tratman	E. St. Louis
1912	233	J. A. Harman	L. K. Sherman	E. E. R. Tratman	Univ. of Ill.
1913	234	L. K. Sherman	J. J. Harman	E. E. R. Tratman	Chicago
1914	246	J. J. Harman	W. S. Shields	E. E. R. Tratman	Peoria
1915	241	W. S. Shields	Paul Hansen	E. E. R. Tratman	Springfield
1916	226	Paul Hansen	W. D. Gerber	E. E. R. Tratman	Univ. of Ill.
1917	235	W. D. Gerber	J. G. Melluish	E. E. R. Tratman	Chicago
1918	252	J. G. Melluish	J. W. Dappert	E. E. R. Tratman	Quincy
1919	256	J. W. Dappert	F. W. DeWolf	E. E. R. Tratman	Bloomington

ILLINOIS SOCIETY OF ENGINEERS

Extracts From Constitution

ARTICLE III—MEMBERSHIP

Section 1.—The membership of the Society shall consist of Members, Honorary Members and Affiliated Members. Members shall constitute the corporate membership of the Society and shall have the exclusive right to vote and hold office in the Society; but members of all grades shall have the right to vote and hold office in the various sections.

Section 2.—A Member shall be a person qualified either by education or experience to design, execute or maintain works of an engineering or public character.

Section 4.—An Affiliated Member shall be a person who may not be qualified for membership under Section 2, but who is interested in matters relating to engineering work or who is interested in the manufacture and sale of supplies and materials used in engineering construction or who is a student in residence in a college of engineering of recognized standing.

ARTICLE IV—ADMISSIONS

Section 1.—Each candidate for membership shall make application in writing to the Secretary on a printed form provided therefor. Such application must give personal reference to three engineers, preferably members of the Society.

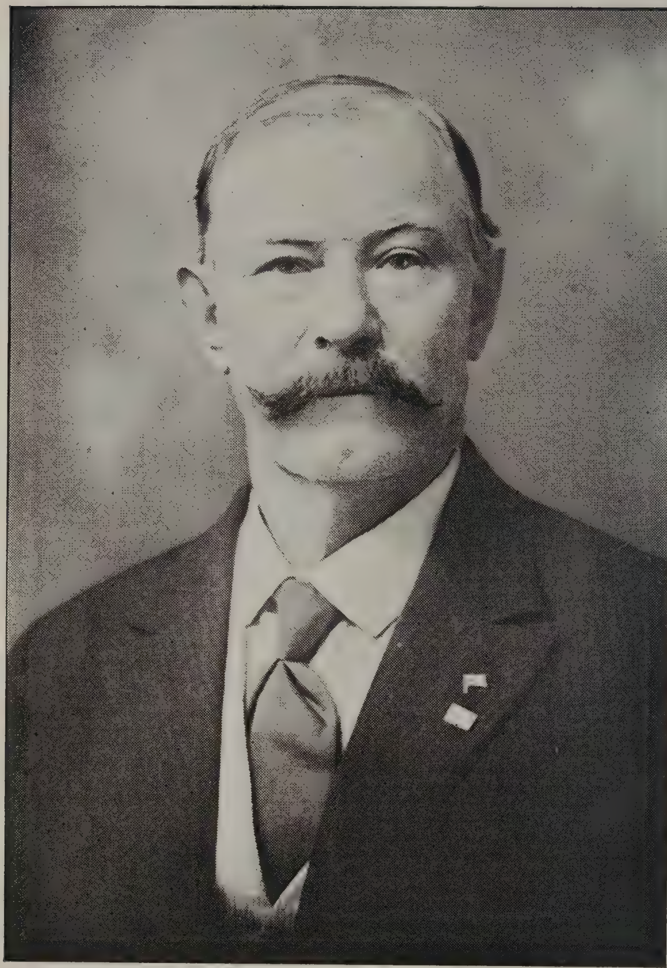
Each application for membership shall be accompanied by the admission fee which will be refunded if the applicant is not elected: ($3 for members, $2 for affiliated members.)

ARTICLE V—DUES

Section 1.—The admission fees and annual dues for the various grades of membership in the Society shall be as follows:

	Entrance Fee	Annual Dues First Year	Annual Dues Succeeding Years
Member	$3.00	$2.00	$4.00
Affiliated Member	2.00	none	2.00

Section 2.—The annual dues are due and payable in advance.



JAMES W. DAPPERT
(Civil Engineer, Taylorville)

President
of the
ILLINOIS SOCIETY OF ENGINEERS
1919

PRESIDENT'S ADDRESS

J. G. MELLUISH, PRESIDENT, 1918

Into the year just passed since we met at Quincy has been written the history of the world's mightiest military efforts. Few of us have been privileged to participate in the struggle which has engaged our national attention; few of us have been able to witness the larger undertakings which have come as a necessity of the war. But it cannot be said that as engineers we have been found lacking in patriotic enterprise. The list of members of this Society shows that about one in five was identified in some war activity, and I venture that 100% of the remainder were loyal workers in some branch of the home service. The war provoked an enthusiasm for doing things and afforded the engineer an opportunity for serving never before offered him. I believe the recognition by the public of the part taken by the engineer in helping win the war has served to secure for him a much deeper appreciation by the general public.

The peace period which we are now entering offers a field so much richer and promising to the engineer that opportunity for usefulness afforded by war fades in comparison. For the engineer to render the maximum of service it will be necessary for him to interest himself much more closely and prominently in civic affairs than he has done heretofore. Through his effort, direction should be given to constructive planning of such public improvements as park reservations, bridges, street paving, sewage disposal, water supply, water power, city planning, municipal buildings, industrial housing, etc. We should cultivate public interest in civic affairs and secure the unified co-operation of the various forces in the community to carry a program of civic improvement into full effect.

A closer affiliation of the various state, national, and other engineering societies will be necessary in order to meet the demands for the solution of the larger reconstruction problems, most of which involve engineering. Recognition by the heads of the various departments of the national government of the status of the engineer must be secured and provision made in legislation enacted by Congress and state assemblies for a suitable technically equipped personnel. Unless the engineers themselves asume the responsibility of leadership, the shaping of these policies will fall into other hands.

To the extent that as American citizens we have been loyal to the demands of patriotism, let us now be loyal to the concern of civilization. Let us regard the task of creating a greater Amer-

ica in times of peace from the viewpoint of the improvement of the individual. Francis G. Blair, State Superintendent of Public Instruction, recently said: "We believe that whatever good comes out of the war must be written in the hearts and minds of the youth of this country. No league of nations or any other instrumentality can enforce peace unless the children of the land are taught the meaning of the word. Education is the one sure hope of democracy."

Let us, therefore, show our appreciation of our American system of public schools, where (as in our present expeditionary army) American youth, rich and poor, foreign-born and native, are reduced to the common denominator of rank and opportunity. Let us foster an idealism for the teacher such as we have never taken time heretofore to cultivate; and let us make her life of self-sacrifice more tolerable by a compensation appropriate to a profession dealing with the building of character. Then will the power of the public school and the schools of higher learning find realization in the truth that "The education of the people is the bulwark of liberty."

RESOLUTIONS

I. *Public Works for Reconstruction Period.* We urge upon every municipality, city, town and county and upon all public authorities the initiation at the earliest possible date of works of public value without delay on the ground of later obtaining lower prices. We believe that the immediate gain to the public in the needed improvement as well as in making available opportunities for work outweigh any prospective saving. We call particular attention to the need of works which guard the public health and add to the comfort through larger and safer water supply, through improved highways and by the construction of drains not only for road improvement but to increase the crop production of the State.

2. *Drainage and Land Reclamation.* There remain to be reclaimed about 2,500,000 acres of swamp and overflowed lands in Illinois, which when protected and drained will increase the land values of the State by at least $100,000,000, but the individual communities have done about all that they can do by themselves, and the situation calls for organization on a large scale, with strong, legal, financial, and engineering backing. The attention of Governor Lowden should be called to the drainage situation with the request to designate a division or arrange for an organization devoted to the drainage needs of the State, with a responsible officer in charge of the investigations and other activities, so that these useless but fertile acres may be added to wealth-producing lands.

3. *State Constitutional Convention.* As a convention for the revision of the constitution of the State of Illinois will probably be called in the near future, this society should appoint a committee on revision of the state constitution, to ascertain what are the provisions of an engineering character and which relate to the conservation and use of the natural resources and are included in the constitutions of other states or which are desirable for inclusion in the new constitution of Illinois. Through this committee the society should co-operate with other engineering

organizations in the State and endeavor to bring about the selection of proper delegates to the constitutional convention, and to keep these delegates informed regarding the fundamental facts and needs, of which engineers have the largest knowledge.

[Note. The executive board later voted not to organize a special committee but to assign the matter of the constitutional revision to the Committee on Legislation, and the latter has a sub-committee to deal with this subject.]

4. *Laws Governing Engineering.* As the State laws affecting the pursuit of civil engineering and surveying are antiquated, illogical and detrimental to the character of work performed, and to the welfare of the profession, and as other organizations are about to recommend amendment of said laws, this society deplores the defects of present laws and the legislative committee is directed to confer with other organizations and if deemed expedient be authorized by the executive committee to act in furthering legislation necessary to meet modern conditions and ideals.

5. *Topographic Maps.* The usefulness of accurate topographic maps in military affairs and in connection with the further development of natural resources, and the construction of highways, the drainage of wet lands, and the building of railways, waterways, and of electric transmission and communication lines is recognized, but the progress of such surveys has been too slow to meet the needs of the public, and there is now an active effort by various organizations to secure much larger appropriations by Congress and by legislatures for a co-operative program, and to eliminate and prevent duplication of work by federal and state agencies. This Society through its legislative committee should take an active part with other agencies in furthering these objects.

6. *Salaries of School Teachers.* As salaries of public school teachers in Illinois are in general so low as to prevent the earning of a fair livelihood, and to discourage competent persons from entering this profession which is fundamental to our future citizenship, and as efforts are being made to remedy the present condition, this Society should endorse and lend its aid to these efforts.

7. *State Department of Public Health.* The activities of the State Department of Public Health have expanded to a point where its services are being demanded by municipalities throughout the state, but the laws now governing the operation of the sanitary engineering division of the Department do not afford the specific authority intended by the act creating the Department. As these activities are of vital importance for the safeguarding of the public health, this Society endorses the proposed bill giving enlarged powers to the Health Department.

8. *Farm Drainage.* The Farm Drainage Act is imperfect and prevents full development of desirable projects, and the 50th General Assembly passed an Act known as Senate Bill 310 which was designed to perfect the above Act but was later vetoed by the Governor. As the identical bill is to be presented to the present legislature and has the endorsement of some of our members, the legislative committee should inform itself about the matter and lend its efforts to assist in the passage of this bill or other legislation designed to improve the present statute.

OBITUARY NOTICES

Lieutenant J. Ivan Dappert

Killed in action in the war with Germany in defense of the principles of liberty. J. Ivan Dappert was born near Ulysses, Kansas, Sept. 23, 1887. During his school days he spent considerable time with his

father—J. W. Dappert—in office and field work as an engineering assistant, and after leaving the High School at Taylorville, Ill., in 1907, he was engaged at different times on a U. S. Government snag boat, on a lighthouse tender, and later with a dredging company on the ship channel for Houston, Texas. In 1909 he was a foreman on construction work for the Chicago, Rock Island & Pacific Ry. in Texas, and about 1911 was engaged on concrete construction work in California.

When this country undertook its part in the great war to resist the world-conquering ideas and barbarian actions of the Germans he registered for the draft in June, 1917. But as his name was far down on the list and two of his brothers were drafted he enlisted in the 4th Illinois Infantry on July 23, 1917. After camp training he was transferred to the 132nd U. S. Infantry which went to France in May, 1918, and reached the fighting front early in June. He was killed in action near Soissons on August 11, 1918. As an example of the American spirit in its eagerness to oppose the evil forces of Germany it is well worth noting that Ivan was one of four brothers who served in this war. The country and the people should do well to honor and remember such men.

Basil B. Gordon, drainage engineer, of Greenville, Miss., was born in Nelson County, Virginia, on June 12, 1853. He began his engineering work as a rodman in 1871 and filled all positions on railway construction work up to that of chief engineer of construction. From 1891 to 1896 he was engaged on Mississippi River improvement work for the U. S. Government and for local levee boards. In 1911 he took up drainage work, settling at Greenville, Miss. He died in December, 1918.

Harry Lewis Wells, city engineer of Aurora, Ill., and county surveyor for Kane county, died Nov. 7, 1918, at the age of 33 years. He had been engaged in municipal and drainage engineering for the past ten years.

Joseph L. Clark, honorary member of the Society and a member since 1888, died at his home in Momence, Ill., in November, 1918. He was a civil engineer in private practice and for many years was county surveyor.

PROCEEDINGS OF THE ANNUAL MEETING

The 34th annual meeting was held Jan. 29-30, 1919, in the hall of the Association of Commerce, at Bloomington, Ill.

January 29. The meeting was called to order at 10:30 a. m. by the President, and after an address of welcome by E. Mark Evans, president of the Association of Commerce, the annual presidential address was read by Mr. Melluish. For the Water Supply Committee papers were presented on "Water Supply and Sanitation at Camp Custer," by S. A. Greeley, and "The Bloomington Water Works," by C. C. Williams, superintendent of water works. For the Surveying Section there were three papers: "Reminiscences of a Chicago Surveyor," M. L. Greeley; "Surveys for the Ogden Avenue Extension, Chicago," R. T. Devereaux; "Surveying in Mexico," Wm. Kramer. The president appointed the following: Committee on Nominations, W. D. Gerber, G. C. Broyhill, C. D. Hill; Committee on Nominations, W. D. Gerber, A. H. Bell, J. W. Dappert.

At the afternoon session the Sewerage Section had the following papers: "Operation of Sewage Disposal Plants in Illinois," M. C. Sjoblom; "Sewage Disposal in Chicago," C. D. Hill; "Calumet Sewer and Pumping Station," L. B. Barker. This was followed by the Drainage Section, with papers on "Drainage in Illinois," by G. W. Pickels, and "Water Resources of Illinois," by F. H. Newell.

At the evening session there was an illustrated talk on "Garbage Collection and Disposal," by S. A. Greeley, and a paper on "The Housing Problem in Illinois," by C. B. Ball, of the Health Department, City of Chicago, was read by C. D. Hill in the absence of the author. The report of the Committee on Co-operation was presented by W. D. Gerber.

The business meeting was then held, at which the secretary presented his annual report. The Committee on Nominations presented the following list, the figures indicating the votes cast. For President, J. W. Dappert (21), A. L. Webster (3), F. W. DeWolf (1); for Vice-President, F. W. DeWolf (20), H. E. Babbitt (5); for trustees, L. B. Barker (15), M. C. Sjoblom (13), H. J. Harman (10), F. C. Lohmann (12). The ballot election resulted as follows: President, J. W. Dappert; Vice-President, F. W. DeWolf; Trustees, M. C. Sjoblom and L. B. Barker. For next place of meeting Urbana had 14 votes; Springfield, 9; Streator, 2. It was voted to hold the 1920 meeting at the University of Illinois, Urbana, Ill.

January 30. Both sessions this day were in charge of the Roads and Pavements Section, with the Chairman, Mr. Piepmeier, presiding. The proceedings opened with a general discussion on water in concrete and details of concrete road construction, followed by a talk on the Illinois $60,000,000 bond issue, by Clifford Older. There were papers on "Design and Construction of Pavement Sections," by H. J. Fixmer, "Brick Road Construction," by G. H. Reiter, and "Methods of Financing Municipal Maintenance," by F. C. Lohmann. The report of the Committee on "Wheel Loads and Tires" was read by J. G. Gabelman. The meeting adjourned at 5 p. m.

The annual dinner was held at the Illinois Hotel, after which Mr. F. H. Newell spoke on "The Engineer's Part in After-the-War Reconstruction," and Senator Kessinger explained his bill to improve housing conditions in Illinois.

MEETINGS OF THE EXECUTIVE COMMITTEE

A meeting of the Executive Committee for 1918 was held Jan. 29 at the Hills Hotel, Bloomington, to consider the report of the secretary and treasurer. The report and financial statement were approved. Announcement was made that retraction has been made by Prof. Baker of statements in his report on Chicago paving which had been considered as reflecting on the engineers. This had been published in some of the technical papers, and noted in a Chicago daily paper.

A meeting of the Executive Committee for 1919 was held at the Association of Commerce Jan. 30. It was voted to appoint a Committee on Legislation and a proposition to appoint a Committee on the State Constitutional Revision was discussed. By ballot vote in February the Executive Committee decided to assign this subject to the Committee on Legislation, with the suggestion that it be given to a sub-committee. The committee elected E. E. R. Tratman as secretary and treasurer, with salary of $250 as before.

THE CHICAGO PAVING REPORT

An investigation of paving work done by the Board of Local Improvements, of Chicago, was made in 1916 by Prof. I. O. Baker for the Finance Committee of the city council. Objections to his report were entered by engineers of the Board on the ground of inaccurate

statements which implied reflection upon the engineers and which were published in the local and technical papers. Under a resolution passed at the annual meeting of 1917 an investigation was undertaken by the Executive Committee, including a study of the report and interviews and correspondence with both parties, and several meetings of the committee were held. Prof. Baker explained that parts of his report were based upon the information which was furnished him by the staff of the finance committee but which proved to be only a part of the information available. He therefore wrote a letter to the President of the Society expressing regret that his report was incorrect in certain particulars and that it included statements which have been considered as reflecting upon the honor of engineers of the Board of Local Improvements, as he had not intended any such reflection. Copies of this were sent to the Chicago papers and the technical papers. The letter was published by some of the latter but not by the former, except that one paper made a brief notice of the matter.

REPORT OF THE SECRETARY

Our membership at the end of 1918 was 250. Two members were lost by death: Lieutenant James I. Dappert, of Taylorville, and Harry L. Wells, of Aurora. We had 27 members in the army and navy of the United States.

It was expected that the new sections would be active in obtaining new affiliated members but little has been done in this direction during 1918. During the year there has not been much activity on the part of either the sections or the committees. This was due in part to war conditions, and three chairmen were out of the state and engaged on government work.

The annual volume of "Proceedings" was of good size and quality, but had fewer advertisements than usual, owing to war conditions. Two bulletins have been issued, and circulars of positions open in government service were distributed as furnished by the U. S. Employment Bureau. Bulletins were sent to about 600 non-member engineers throughout the state, with requests to join the Society.

The financial condition of the Society is fair, but for the past two or three years our expenses have exceeded our income. This means a draft on the surplus which had been built up slowly during preceding years, and we shall need to be particularly careful in 1919. This condition in 1918 was due partly to our generosities, partly to increased costs in every direction, and partly to the discouraging fact that so many of our members fail to live up to the rule requiring payment of annual dues in advance. This rule is almost universal in societies of all kinds, and our members agree to abide by it when they sign their applications. Some of them even complain because they do not receive the exchanges, even when they owe two years' dues, and although the constitution provides that members in arrears are not entitled to the exchanges. No less than 23 members are in arrears for two years and will be dropped from the membership list, while 33 are in arrears for 1918, making a total of nearly $300 due to the Society. Bills, statements and letters have been sent to all delinquents.

As to generosities, the Society remitted the 1918 dues of all members in the army and navy service; contributed to the Citizens Unit and to the war committee of technical societies, the total amounting to about $200. The Citizens Unit is a civilian organization formed to back

up the 108th Engineers (organized in Illinois) by looking after the welfare and interests of the men and their families. This regiment has been in France for some time. The war committee of technical societies was organized at Chicago to aid the U. S. government in securing qualified men needed for technical positions by notifying members of openings and opportunities in government service (military and civil).

The Society was represented at the National Conference on Engineering Co-operation in May, and at the National Drainage Conference in November.

E. E. R. TRATMAN, *Secretary.*

ILLINOIS SOCIETY OF ENGINEERS

Financial Statement

Balance in bank December 31, 1917 (exclusive of savings bank)		$ 363.23

Receipts

Annual dues	$758.00	
Entrance fees	54.00	
From savings account reserve for Liberty Bonds	200.00	
Sale of Proceedings	1.00	
Advertisements	517.00	
Total for 1918		$1530.00
Total receipts		$1893.23

Expenditures

Printing and distributing "Proceedings"		$ 549.57
Printing stationery, circulars, etc.		217.53
Stamps and telegrams		95.20
Express and freight		126.02
Stenographer's report and expenses; 1918 meeting (Quincy)		90.02
Stereopticon at meeting		5.00
Dues refunded; members in U. S. service		12.00
Advertisement in L. K. Sherman's pamphlet		5.00
Badges and service flag		30.00
Subscription to "good roads" dinner; Quincy		25.00
Subscription to "War Board of Technical Societies"		25.00
Subscription to Citizens Unit; for 108th Engineers		50.00
Committee expenses, Baker report		17.22
Secretary		250.00
Typewriting		54.35
Liberty Bonds		200.00
Total expenditures		$1751.91
Total receipts		1893.23
Bank balance December 31, 1918	$141.32	
Savings account reserve	300.93	
Liberty Bonds	400.00	
Total assets, December 31, 1918		$ 842.25
Total assets, December 31, 1917		1064.16
Due from members, back dues ($116 by 33 members for 1918; and $180 by 23 members for 1918 and 1917)		$ 296.00
Due from advertisers		None

THE ENGINEER'S PART IN AFTER-THE-WAR RECONSTRUCTION PROBLEMS

BY F. H. NEWELL

The engineer, as his designation implies, is the man of ingenuity, the man who has a vision of the future and who, without being visionary, can see and devise methods of producing results by utilizing the forces and resources of nature. His business is to plan and build. During the war his was the task of devising ways of protecting friends and destroying enemies. Now with peace assured, his task is to get the machinery of construction and operation into full motion again. His part is also that of the pioneer to explore, to conduct researches into realms beyond our present knowledge and with facts thus secured plan out the safe way for others to follow.

In Illinois, as elsewhere, the war has served to greatly widen the viewpoint of the people. It has made possible the realization of some of those ideals which a few years ago were regarded as impracticable. This has been stated by Winston Churchill: "If for five years after the war the people devote the same energy, co-operation and self-sacrifice to reconstruction as have been devoted to the process of destruction, there is no social, industrial, or economic problem which could not be conquered."

What are the steps to be taken by us as engineers in order that we may do our full duty as citizens? It is desirable to emphasize the fact that engineers as a class owe a larger duty to the public than almost any other group. They have been educated largely at public expense and given the opportunity of enjoying a wider outlook upon the forces and activities of nature than have most of our fellows. They have already shown what they can do under the stimulus of war. Now under peace conditions—which should be even more inspiring—it is for them to demonstrate their continued value to humanity. The question is as to how this can best be performed.

Under our form of government any notable advance or improvement must be made largely through the support of the majority of the thinking people. To secure wise action it is obviously necessary that the public be well informed as to the objects to be attained and relative costs and benefits involved. The engineers should do everything in their power to diffuse information regarding the matters in which they are skilled in order that the public may be able to act intelligently.

Closely connected with the duty of diffusing information is that of encouraging the acquisition of additional information regarding natural resources and the methods of utilizing these. Here engineers individually and collectively have a duty in stimulating continued study and research.

It is incumbent upon the engineers to use the experience and ingenuity with which they are endowed to make general plans and bring before the public the possibilities of larger health, comfort and prosperity. It is true that the details can only be worked out with safety after adequate funds have been provided, but it is nevertheless possible to outline the picture in a broad way and to keep continually before the people or communities concerned a conception as to what may be done.

It may be urged that the engineer is too busy a man to undertake this, but reflection will show that even the busiest man must have a certain relaxation and will be improved mentally and morally and possibly may gain in a financial way if occasionally he lifts his eyes from his desk and permits his mental vision to take in the larger aspects of the things with which he is familiar. Moreover, the contact with his fellow men in directing their vision to the wide scope of engineering possibilities must have a beneficial effect in counteracting the narrowing influences of professional detail.

The immediate and vital question following the war is that of providing employment for returning soldiers and war workers and the reconstruction of the crippled or injured men. This reconstruction of men is the first and most pressing duty, one in which the time element is vital. Here is demanded not charity or political discussion but immediate practical action. This can come about in many ways:

1. By urging that each and every employer take on as many people as he can and in spite of present high prices incur every reasonable business risk in getting his operations under way.

2. By urging public officers and persons having control of expenditures of public or private organizations to undertake at once the works which have been planned or contemplated such as highways, waterways, water supply, drainage systems, public buildings, parks and all those things which benefit the public. In opposition it is urged that there is scarcity of material and prices are high. But is often possible to substitute materials, and even though prices may be high it is a matter of public economy in the long run that the work be performed now and that an outlet be afforded for labor on things which are ultimately of use.

It is the engineer who must supply many of the facts and conclusions upon which the policies of the reconstruction period may be based. Without his intelligent direction little progress can be made. The great war has awakened Americans to the fact that in their somewhat complacent attitude of mind they have permitted European nations, especially Germany, to far outstrip them. As a result, when war came suddenly upon us, we were compelled to lose time, and directly or indirectly sacrifice thousands of lives and millions of dollars in accumulated wealth.

In all of these matters which pertain to the conservation and use of the resources of the country, both material and human, and the development of ideals, the engineer should be active. While his profession may not include the direct control of capital and credit, of foreign and domestic trade, of agricultural distribution, and of many purely business questions, yet he should be such a factor in the fundamentals of these that his knowledge and skill cannot safely be neglected.

Now comes the question as to what the engineer and his organizations should do in the present crisis of world affairs. The reply seems obvious that as an individual he should take an active part in these world problems. Every engineering society should have its committee on reconstruction, charged with the duty of arranging for effective presentation of one or another of such great subjects as employment of labor, research, raw materials or fuels, power, transportation, public utilities, and other matters, all of which are undergoing radical changes. The trend of these should be studied and the influence of the engineer as an individual should be wisely used.

This society under this conception has a great duty and responsibility to its members and through them to the public. The standing of the engineering profession in the near future must be determined largely by the wisdom of the action taken now in approaching these great problems of reconstruction.

REPORT OF COMMITTEE ON CO-OPERATION

Soon after our 1918 convention this committee undertook its work. Calls were made upon the officers of various technical societies in Chicago to whom we outlined the necessity of a central co-operative committee of all the technical societies in the state. We were much impressed with the cordial reception with which our proposition was received and the assurances of co-operation. The war has been responsible for holding up many activities and was no exception in our case. Almost at the outset we learned of the urgent need for co-operation of engineering societies for war purposes and of a proposition to create a war service committee for co-ordinating war activities of the various technical societies. Feeling that under the circumstances it would be far better to give our support to this movement than to try to develop on our scheme, the Illinois Society of Engineers through its committee agreed to join in this war service movement.

On May 26 a meeting was held at which there were in attendance 26 representatives for 18 societies. Your committee was keenly disappointed when it developed that this was a movement to be circumscribed to a Chicago zone rather than to be state wide.

As ours was the only society which saw the desirability of state-wide co-operation we took our defeat as gracefully as possible in the hope that upon the termination of the war such an organization could be expanded to take in the whole state. The name adopted was the War Committee of the Technical Societies of Chicago. Its work included assisting in finding men to fill technical positions in various branches of the army and in finding such positions for applicants. It assisted also in securing subscriptions to the Liberty Loans.

With the signing of the armistice the committee's purpose ended, but at a meeting held on Dec. 6 it was voted to continue its activities for the betterment of the community and the dignity of the profession. The name was changed to the General Committee of the Technical Societies of Chicago. The financial report presented at that meeting showed a balance on hand of over $1000 after paying all bills. An admission fee of $25 was charged by the original War Committee. This is not an annual assessment, but assessments will have to be made when the present funds have been exhausted. It has been decided that this General Committee shall develop an employment service. This is a very important phase of engineering co-operation, but your committee does not think it the only important one nor that it should be given preference to the exclusion of other highly desirable activities.

Every technical man in the state should be made to feel the importance and necessity of adding his weight and backing to movements designed to develop and establish the professional standing of all technical men in the State. A start to bring this about must be made from down-state as well as from Chicago. To this end it seems desirable that all technical societies and clubs should be invited to participate in such a co-operation movement, and that an effort be made to organize in every county a county technical society, membership to be open to any technical person in the county. Meetings should be held frequently enough to maintain the interest of such locals and a delegate should be named from each local society to represent it at any State meetings which may be called. It would be highly desirable if such local societies could be organized as county or city chapters of the Illinois Society of Engineers. This work of local organization should be undertaken at once so that we may, as a closely knit group, coordinate our efforts and put punch into whatever we undertake.

A State constitutional convention has been voted for and there may be many things taken up during this convention of vital importance to engineers and engineering. We should be prepared to deal with such problems with a full understanding of their effect upon us, as technical men as well as upon those who are our clients. We recommend that the committee on co-operation

be made a standing committee* and be enlarged to five members and that an active campaign be undertaken to develop the local society feature.—W. D. GERBER, S. A. GREELEY.

J. A. HARMAN: In this reconstruction period there are new problems confronting the engineering societies. To make the committee's suggestion effective it must be backed up by a carefully stated policy of what the society proposes to do. In fact the most important thing for engineering societies in general is to formulate a policy, and it seems that they might well take up the question of employment.

STATE CONSTITUTIONAL REVISION: DISCUSSION

W. D. GERBER: In view of the coming constitutional convention we should have a state legislative committee of not less than five members, and I suggest that the attention of this new committee be called to the convention.

A. N. TALBOT: Will it be possible for this legislative committee to consider and take action on questions of policy with reference to the new constitution? There are a number of questions bearing on engineering construction and operation which should be taken up in deliberating on a new constitution, questions in which this society would be interested, such as whether the provision for special assessments may not be extended to other lines of work, whether the special assessment principle (or something similar to special assessment) may not be used to raise taxes to provide operating funds for upkeep of sewage disposal plants, repairs of pavements, removal of snow, street cleaning, etc. There are a variety of questions that may come up where proposals may be made, perhaps rather radical ones, good and bad, with reference to methods of raising funds and of carrying on engineering operations. It seems to me the society should seize the opportunity to be useful in these matters.

C. D. HILL: Prof. Talbot brings up the point of law rather than engineering, and shows the necessity of engineers co-operating with lawyers in this constitutional revision. Last year there were one or more lawyers taking part in our discussion and I am in hopes there is a member of this Society who has practical knowledge of the special assessment law, and who is accustomed to working with engineers. Then we would be guided in these questions of policy much better than without such legal advice.

E. A. ROSSITER: Relative to Mr. Talbot's suggestion for a special assessment for the maintenance of sewage disposal plants, under our drainage laws a small tax per acre or lot (known as annual tax) is levied for the upkeep of a drainage district. Such

*Note. Under the revised constitution there are no standing committees.

a tax might be levied at the time a special assessment is made for sewers for their upkeep and maintenance which will relieve the necessity of taking the general funds of the city or village.

G. C. HABERMEYER: It would be well to take the opportunity to have some surveyors called in to help revise the old laws under which they are working.

Note. At a meeting of the executive board, held after adjournment, alternative suggestions were made to appoint a special committee on the State constitutional revision and to assign this subject to a new committee on legislation. A letter ballot vote after the meeting resulted in favor of the latter plan. A suggestion was made, however, that the committee on legislation should appoint a sub-committee to look after the constitutional revision, and this action has been taken by the chairman of the new committee.

OPERATION OF SEWAGE DISPOSAL WORKS IN ILLINOIS

BY M. C. SJOBLOM

The following report has been prepared, not for the purpose of giving detailed directions as to how a sewage-disposal plant should be operated to secure the best results, but rather to point out the attitude of the average community toward the operation of its sewage-disposal works and the shortcomings relating to the attention given the plant. It is also the intention to suggest a few of the things that can in many cases be done to improve conditions and to request you, as engineers, to give the matter some thought, for as now operated the average plant which you design will not be of much value. A brief account will be given of a few plants in the State, showing what attention is being given to them by the municipalities they serve. These plants have not been selected because they were known to be poorly operated, but were selected from the fact that they were practically all in one locality and easily reached.

Wheaton (3000 population) passes the greater part of its sewage through a small septic tank, from which it is discharged directly into a drainage ditch affording an inappreciable dilution. This creek passes through a territory containing two golf club grounds and also in the vicinity of a number of attractive homes. For some reason, probably due to the volume of sewage passing through the tank, the city made a connection between the sanitary and storm sewers and a large part of the sanitary sewage entered the ditch without any treatment. This connection was recently removed.

In spite of the fact that action had been taken to prevent the city from polluting the ditch to its present condition the tank was given no attention with the result that sludge practically filled the

sedimentation tanks, scum having accumulated to a height of about 15 inches or more above the flow line. In this case tank treatment alone is not sufficient to prevent nuisances. Nevertheless, there is no reason why it should not have been kept in the best possible condition to perform the duties for which it was installed. The tank has recently been cleaned after incessant pressure was brought to bear.

Downers Grove (3000) has a sewage-disposal plant consisting of a large septic tank and a number of what must be called trickling filters. These consist of several beds containing crushed rock and the sewage is applied at intervals through troughs. Two years ago, when inspected, the tank had not been cleaned for a long time, and as a result the retention period had apparently become inappreciable, the sewage apparently passing in a small channel through the sludge and the crude sewage appearing at the outlet. The beds were used very little, if any, at that time, but even if they had been used would do little good as the troughs had been permitted to deteriorate to a point where practically all sewage would flow to one point on the bed. Here the sewage would become matted over with a poorly settled sewage. At a recent visit the tank was still uncleaned, and crude sewage was passing directly through. It was learned also that the beds had not been used during the past year.

Naperville (4,000) passes its sewage through a septic tank, the effluent being discharged into DuPage River a short distance below town. No attention was given the tank for several years until it became so badly clogged with sludge that the sewage backed up and passed directly into the stream through a by-pass. After this was discovered about a year ago, one side of the tank was partially cleaned and then let go through the setting in of cold weather. Again this fall work was begun on cleaning the tank, but only an inappreciable amount was removed. At the present time no good is obtained from the use of the tank, large quantities of undigested sludge as well as black septic sludge passing directly into the outlet.

Glen Ellyn (2,000) has a plant consisting of a two-chamber septic tank, a dosing chamber and filter beds having a filtering medium of finely crushed rock. It was stated that the tank was cleaned the past spring and there is every reason to believe this to be the case, as no scum was found on the surface and effluent is apparently very satisfactory. During winter months no great amount of attention is given the beds and at the time of the visit the sewage was passing directly through the dosing chamber and was passing through one bed continuously.

La Grange. In a paper read before this society two years ago this was mentioned as one city where the sewage-disposal works were given systematic attention. A recent visit found conditions

unsatisfactory, due to the fact that someone had gained access to the sprinkling filters and had stolen all the sprinkling nozzles and the city had not had time to replace them. The sewage, therefore, was not passing onto the filters, but the effluent from the septic tank passed directly into DuPage River.

Harvard (3,500) is one town which gives considerable attention to its sewage-disposal works and secures satisfactory results. The plant consists of a septic tank with two chambers, a dosing chamber and several intermittent sand filter units. The tank is cleaned twice yearly, the sludge being dumped outside the building which covers the tank. The beds are used from early spring until the cold weather. During this period a man is kept at the plant six days a week. During the winter a man visits the plant every morning to see that the inlets are clear. Good results are secured here, not because of the exceptional design of the plant, but because of adequate supervision.

Pana (7,000) has a plant consisting of an Imhoff tank, dosing chambers and sprinkling filters, serving the greater part of town. On a recent visit the plant was found in a deplorable condition. The north end of the settling chamber, at which end the sewage had been entering for some time, was covered with a thick scum while the remainder had a scum to a less degree. Some of the large gas vents were practically filled with heavy dry scum. An understanding as to the condition of the scum may be had from the fact that while poking the scum with a stick two large rats emerged from holes in the surface. In addition to this condition in the tank the distributors over the filter beds are not properly cleaned, with the result that sewage is dosed over a portion of the filtering area.

Repeated visits to plants throughout the State indicate that the same towns continue to be offenders regardless of changes in men to look after the plant. It is evident, therefore, that the city officials, as well as the men in charge of the plant should be impressed with the necessity of making proper use of the works installed. That so many of the septic tanks are permitted to go uncleaned for years results no doubt largely from the fact that the average layman is of the opinion that the sludge eats itself up, and considerable good will result if every engineer who designs a plant makes it a point of impress (even to the point of being rude) upon the responsible parties of the necessity for at least annual cleaning. The theory of the tank should be explained and the effect of filling up and the necessity for ample retention periods should be gone into to an extent that will make the authorities of one mind in the matter. In one case several of the city authorities each had his own idea as to the proper operation of the plant, with the result that the operator did not know what to do. He had been told to sprinkle lime over the scum to consume it and as a result

small dabs of dry lime were sprinkled over the heavy, dry crust covering the tank. In this case a heavy dry crust (heavy enough to walk upon) was found in the settling channels of an Imhoff tank.

The engineer should formulate definite rules and furnish them to the cities having disposal plants. These should give the routine work to be carried out, in order to receive satisfactory results. Several copies should be furnished, and if necessary some might be framed and placed at the most advantageous points so that there can be no excuse for pleading ignorance if proper attention is not given. Among these rules the necessity for cleaning the tanks should be duly emphasized. A simple plan of the tank should also be shown, with different parts labeled to help the attendant in interpreting the directions.

Another feature is the method of removing sludge from the tank. Where a tank is designed so that the sludge can be removed through static pressure little perhaps need be done by the engineer further than to be sure that it will operate and to give general rules as to removal. Where ordinary tanks are concerned, however, from which the sludge must be removed from the top, definite plans should be included with the tank design and installed as a part of the tank. Definite rules should also be given as to the best method of removing the sludge. In a number of places, the removal of sludge appears to be a bug-bear and only too often devices are created by some local official and installed at considerable expense only to find that they do not do the work for which they are intended. It should be made plain to the proper authorities that to leave the sludge for years, with the result that large accumulations will be formed on top and become dry, will simply make cleaning more difficult.

As found in Illinois, and no doubt also in other states, the great question in regard to the operation of sewage-disposal plants in the smaller town is not the formulation of a large number of rules. The great question is how to get the smaller cities and villages to realize the necessity for caring for their sewage works and to bring about definite action. A few instructions giving the most essential details in plant operation, if followed, will do more good than to fill the attendant with a large number of instructions, the most important of which are not duly emphasized and the number so large that none of them will be followed. As now operated the average sewage-disposal plant in the State is practically worthless. This may suggest to some that the State Department of Public Health is careless or inefficient, but that body has no jurisdiction over these plants after installation, and a sufficient number of employees has never been provided to take up this work in detail in connection with the other duties of the department.

Plants properly designed but poorly operated work against

the best interests of the engineer both in the town having the works and in the towns surrounding. Many municipalities contemplating the installation of sewage-disposal works first visit some near-by plants. If these plants are poorly operated, no matter how perfect the design, the engineer is thought responsible for the poor conditions found.

DISCUSSION

H. P. MATTE: A bill has been prepared to enlarge the powers of the State Board of Health in regard to supervision of operation and maintenance of plants:

No public water supply, or any modification or extension to an existing public water supply which involves changes in or additions to sources of supply or to means for gathering and purifying the water; and no public sewerage works, or any modification or extension to existing sewerage works which involves changes in size or location of outfalls, changes in size, character or capacity of sewage treatment works or the addition of main, relief or intercepting sewers, shall be installed until suitable plans and other descriptive matter have been submitted to and approved in writing by the department of public health. The department shall have power to adopt and enforce rules and regulations governing the manner and form in which such plans and other descriptive matter shall be presented.

If the department of public health finds that water purification works or sewage treatment works are not being operated so as to produce the results of which they are normally capable or so as to protect the public health, it may issue an order requiring the employment of competent operators, the use of effective operating methods and the submission of reports on operation. If it is found that a public water supply or the disposal of sewage from public sewerage works is a menace to health or a nuisance, the department may order that the danger to the public health be removed and that the nuisance be abated in a manner subject to the approval of the department.

The necessity for and reasonableness of such order may be submitted to two reputable and experienced sanitary engineers, one to be chosen by the city, village, town or owner to which such order applies and the other chosen by the department of public health (neither of them being regularly employed by the department) and who shall act as referee engineers. If these engineers are unable to agree, they shall choose a third engineer of like standing, and the vote of the majority shall be final and binding. The referee engineers shall have power to affirm, modify or reject the order of the department of public health submitted to them, and their decision shall be accepted by the department. The fees and expenses shall be equally divided between the city, village, town or owner and the department of public health.

In matters involving the enforcement of orders of the department of public health relating to public water supply and sweerage, responsible municipal officials shall be held personally liable for failure to perform any act within the scope of their official duty and within their individual power.

F. L. PFEIFFER: In regard to extension of water works, we have had insurance companies pressing the city authorities to enlarge the water mains for more fire protection. How are you going to advocate a proposition of this kind to a state legislature, and take

the powers from municipalities to further the interests of insurance companies?

H. P. MATTE: This bill has nothing to do with extension of water mains. It applies in case you wish to extend or change your water supply system.

C. D. HILL: One of the ideas brought out is that the State Department should be strengthened in its authority. There is always danger of going too far in anything of that sort, but we can go considerably farther than we have gone. That necessitates legislation. I would like to have suggestions as to what extent it is well to have our Department of Health supervise the operation or design of sewage disposal plants. There is danger at this stage of the development of sewage disposal that the department may require too much. We have to guard against going to extremes. On the other hand, local officials have no idea of the technique of sewage disposal, and little interest in the matter. These plants should be taken care of with some supervision, and the supervision should be furnished by the State.

J. W. DAPPERT: I find that it has been almost impossible to get adequate supervision of septic tanks and works of that sort, and I have wondered by what method it would be possible to get proper handling. So far, they have been a failure, simply from the fact that there has been no proper supervision. I would be in favor of some such an act as has been presented. The greatest difficulty is that there are no adequate funds provided in the cities. In Illinois these city works are being run along on half pay, so to speak. None of the corporations have funds sufficient to carry on any new works, or even in many instances to carry on the old works. Some sort of legislation must be provided. Up to this time, the taxes were hardly sufficient to take care of the average everyday expenses. There must be some method by which the matter can be taken up before the legislature so that the finances of these works can be taken care of.

S. A. GREELEY: This is the second time Mr. Sjoblom has brought this important matter to our attention. Two years ago he reported on ten plants. In the engineering journals there has been discussion recently of the sewage treatment methods to be adopted at Cleveland and other cities, with special reference to Imhoff tanks, fine screens and filters. We have made a thorough canvass of the elements of Imhoff tanks, seeking the reasons for some reported failures. There are certain factors in Imhoff tank design that are very important, such as depth, sludge capacity and area for floating sludge. Troubles have occurred in tanks where some of these elements have been materially reduced, due to attempts to build within certain available but insufficient funds. In other words the engineer was not given the necessary financial assistance. We tabulated results of operation of testing station

tanks in order to see the comparative results. At a number of small plants at country clubs, etc., it has been found not too costly to provide very liberally in these elements. The floating sludge area in large tanks is generally less than 25% of the total tank surface. In the small tanks you can, without undue cost, provide as much as 50%, and this liberal allowance reduces troubles from operation to a minimum.

The bill for increasing the power of the State Board of Health seems to have a great deal of merit. Before Mr. Hansen went into the army he made a very careful canvass of all laws covering this subject, and he has been discussing the question for the last three or four years. There is perhaps room for change in the method of financing to provide funds for operation of sewage works. We do have the sanitary district law which enables towns to combine and provide separate taxing powers which appear reasonable, to provide for both construction and maintenance of sewers and sewage treatment works. The Sanitary District of Decatur can raise something like $50,000 per year by a direct levy without going to the people.

THE CALUMET INTERCEPTING SEWER AND PUMPING STATION

BY L. B. BARKER

The Calumet intercepting sewer, now under construction by the Sanitary District of Chicago will extend from the present sewage pumping station at 95th St. and Baltimore Ave., south and west to the controlling works of the Calumet-Sag channel, just east of the city of Blue Island, a distance of a little more than 9 miles. There will also be an interceptor draining that territory lying on the east side of the Calumet river south to 114th St. to the 95th St. pumping station. The total area tributary to the intercepting system will be in the neighborhood of 20,000 acres, and comprises all that part of Chicago south of 87th St. The Calumet intercepting sewer will, therefore, complete the diversion of all sewage from Lake Michigan from Glencoe south to the Indiana State line.

The first section of the interceptor includes the building of an 11-ft. horseshoe section sewer from the 95th St. pumping station, south to 97th St., a distance of about 1,300 ft., an intercepting sewer south and east of the Calumet river and under the river to the 95th St. pumping station, and certain improvements which will double the capacity of the pumping station.

Contracts No. 2 and 3 were completed in the fall of 1917 by Byrne Bros. Dredging & Engineering Co., Chicago. These are concrete 11-ft. and 13-ft. horseshoe sections, respectively, extending

from 97th St. and Baltimore Ave., south and west to just north of the north end of Lake Calumet, a total length for the two of approximately 12,000 ft. Contract No. 4 has just been completed by Nash Bros., Chicago. This section extends from the south end of Contract No. 3, south and west to 104th St. and South Park Ave., about 8,700 ft. It is a concrete horseshoe section having an internal width of 16½ ft.

Work was started last fall on contract No. 5 by Byrne Bros. This is a 17½-ft. horseshoe section, 8,160 ft. long from the end of No. 4 to 114th St. and Prairie Ave. Contract No. 6 is the same size as No. 5 and extends from it to the site of the Calumet pumping station at 124th Place and Indiana Ave. This contract was completed last fall by Byrne Bros. Contract No. 7 is the outfall sewer from the pumping station to the controlling works of the Calumet Sag Channel at Blue Island, a distance of 11,300 ft. From the pumping station to Wentworth Ave., where it receives the flow of the old 10½ ft. Wentworth Ave. sewer, it is a 16x13.4 ft. horseshoe section. Beyond Wentworth Ave. is a 16x16 ft. Croton section to 600 ft. above the controlling works, where (because of the shallow cover) it was necessary to make it a 16x13 ft. box section, reinforced. Like the other contracts, the Croton and horseshoe sections are un-reinforced except for various special lengths, such as crossings under railroads. Near the upper end of contract No. 7 is a flat-roofed gaging chamber, 60 ft. long, in which are provided a timber weir and gaging wells for measuring the flow of sewage from the pumping station. This contract was completed by the T. J. Forschner Contracting Co. last fall.

The Calumet sewage pumping station, now under construction by this last company, lies under contracts 6 and 7 of the sewer at 125th St. and Indiana Ave. The difference in elevations between these two sections is 16 ft., and the maximum lift will be 20 ft. for a capacity of 300,000 gals. per minute. There will be six centrifugal pumps, electrically operated by power furnished by the Sanitary District from its Lockport plant. Three of these pumps are 72 inches in diameter and three 36 inches. The building will be of brick, 80 x 185 ft., having a concrete sub-structure which will provide for suction and discharge channels. The transition section from contract No. 6 will include a screen chamber, and besides the dry weather and storm discharge channels to contract No. 7 there will be corresponding discharge channels to a 13-ft. relief sewer to the Calumet river, and also a connection to a future treatment plant.

The chief point of difference between the construction work on the Calumet sewer and that of most jobs of this kind is the use of the drag-line for the excavation. All sections of the sewer yet under construction, except contracts 2 and 3, have been in exceptionally deep cuts and the yardage has been so large that with the use

of only one excavating machine, progress would be very slow. Therefore, the combination of steam shovel and drag-line has been employed. This is well illustrated in the case of the outfall section, contract No. 7.

This section was built in open country, partly through easements in private property and partly in country roads, and for the greater part of the way the contractor obtained additional easements of a 30-ft strip along the right-of-way, so that there was ample room for the operation of his plant. The ground was, in general, a sandy loam, mixed with yellow clay to a depth of 10 ft., and the balance blue clay; in some places almost a dry hard-pan. A few small sand pockets were encountered and for a few hundred feet at the lower end, the bottom was soft and wet, making reinforcement necessary.

Except for the first thousand feet, the cut ran from 24 to 28 ft. deep. The excavation was made in two lifts, the first of which was taken out to a depth of 12 to 14 ft. by a Marion steam shovel, operating a 2½ yd. bucket. This cut ran from 50 to 64 ft. wide at the top, depending on the nature of the ground, and averaging 26 ft. at the bottom, the shovel moving on its own track in the cut. The second cut was made by a Bucyrus drag-line having a 2 yd. bucket on a 65-ft. boom. This was operated in the bottom of the shovel cut, keeping, usually, about 300 ft. back of the shovel. The drag-line cut averaged 14 ft. deep and was made with vertical sides to the neat lines of the outside of the sewer section. Very little hand trimming was necessary as the drag was able to work very close to both line and grade. For the first 6500 ft., continuous 3 in. sheeting was used in the lower cut as the ground there encountered sloughed badly unless supported. Better ground made it possible to leave out from 30 to 50% of the sheeting for the balance of the job.

Excavated material was loaded by both shovel and drag-line into 6-yd. dump cars on standard gage track laid along one side of the trench and taken by dinkey engines to the spoil area or used for the backfill. During the first season a standard-gage spreader car was used on the backfill, a trainload being first dumped along the side of the trench and the spreader then coupled on to the train and pulled over the freshly dumped material. Excess excavation was hauled to a site on the Calumet river about midway of the job. With this equipment an average daily progress of 55 ft. of trench was maintained through two seasons.

Concrete materials were brought from the central material yard by dinkey trains of ten steel dump cars of 40-ft. capacity on 30-in. track. Mixing was by means of two Foote mixers of 1 cu. yd. capacity, discharging directly into the forms from the side of the trench. Blaw steel forms were used on the Croton and horseshoe sections. These were moved in 25 ft. units on a special

traveler operated by a small gasoline winch over track laid on the finished invert. The invert was concreted each day for the full length of the finished trench and the arch was usually two to four form lengths back of its forward end.

A daily run of 300 to 400 cu. yds. of concrete necessitated rapid and economical handling of materials. This was obtained by a central material yard located on the Pan Handle Railroad at about the middle of the job. The plant consisted of a main switch track from the railroad and two storage tracks, specially designed hopper bottom bins for sand and stone of 430 cu. yd. capacity, a cement handling house and two cement storage houses. Sufficient ground space was provided for the storage of 5000 cu. yd. of stone and sand. The stone and sand were unloaded from the cars into the bins or on the storage piles by a 15-ton Brown-Hoist locomotive crane with a 40 cu. ft. clam shell bucket. The cement handling house was designed for the use of bulk cement, but proved equally advantageous with sacks. This house was built on posts high enough for the concrete trains to be backed under it. In the floor were ten small hopers having a capacity of 6 cu. ft. each. At the bottom of each hopper was a slide gate operated by a lever outside the house. These hoppers were kept filled with the required amount of cement brought in from the cars or the storage houses adjoining, and as a concrete train was backed underneath, one hopper was emptied into each car.

One special feature of this job was the crossing of the old 10½ ft. brick sewer at Wentworth Ave. The invert of this was only 18 inches higher than the invert of the interceptor, and a flow, sometimes reaching 250 sec. ft. had to be diverted, not only during the construction of the sewer, but the diversion maintained until such time as the intercepting system is put into commission. To do this an inverted syphon was built at one side of the Wentworth Ave. sewer and below the interceptor. This was of reinforced concrete, 6 ft. inside diameter, having a length of 90 ft. not including the connecting stubs. It was built in the tunnel the winter before the construction of the interceptor had reached this point. The connections having been made, brick bulkheads were built in the old sewer on either side of where the new one would cut through and the flow diverted through the syphon. When the trench was finally cut through over the syphon, no leakage from the syphon was found, and the progress of the work was not delayed for the crossing.

Considerable difficulty was met with on some of the other contracts because of lack of room for construction in built up streets: This was especially true on contract No. 6 where a 17½-ft. sewer was built in a 34-ft. cut. The same method of excavation was used here as on No. 7 except that of course, the top cut was made narrower. Fortunately the clay here was of such consistency

that the sides of the cut stood up at a steep angle without much sheeting. Even so, but very little room was inside the street lines for the concreting and backfill equipment. To overcome this a specially designed arrangement was used to handle the backfill. This consisted of a pulverizing machine mounted on a truck on a standard gage track on one side of the cut, operated by a 15-h.p. motor, and a belt conveyor 125 ft. long also on trucks and operated by a 25-h.p. motor. A part of the material excavated by the drag-line was dumped by it directly into the hopper of the pulverizer which ground up the large lumps of clay and fed it onto the conveyor where it was carried back to the completed arch.

A very ingenious modification of the concrete plant was also made. The charging bucket and hoist were removed from a standard ¾-yd. mixer and a 25-h.p. motor used instead of steam. A track was then built from the ground up over the top of the mixer and down to the ground again on the other side. The narrow gage concrete tracks on the ground were laid up to either end of this. An endless chain, geared to the motor, passed over the elevated section of track and under the mixer. Hooks on this engaged the axles of the concrete cars as they were pushed to the receiving end and drew them up over the mixer, where they were dumped into a vertical hopper which fed into the mixing drum. The whole affair was moved on a standard gage track.

The T. J. Forschner Co. is employing much the same method of construction on the substructure of the Calumet pumping station as on contract No. 7 of the sewer. Practically the same arrangement of material plant is being used and all excavation is made by drag-line, a second drag-line handling the excavated material. The cut, which has a maximum depth of 35 ft. was made by the No. 1 drag-line operating from the top of the ground and making the full depth in one lift. A cut was first made about 18 ft. wide at the bottom along the line of the greatest depth, for its full length. The next deepest bench was then excavated at the side of the first cut, and so on. A small gang of bottom men worked along with the drag, trimming the bottom to the required lines and grades. No sheeting has been used, as the ground stands well at a 1 to 2 slope. Excavated material passed up by drag No. 1 is again picked up by drag No. 2 and piled back clear of the cut. The drag-lines were also used for stripping the top soil off the pumping station site and will be used to spread and grade the filling around the building.

The same concrete plant is being used as on contract No. 7, so far all concrete being chuted from the sides of the cut. Columns are poured with two-wheel concrete buggies. For the pump room floors and interior walls, the same plant will probably be used, but will have to be carried out onto the outside walls which are now built to ground level. Wooden forms are being used

throughout, and on account of the cut-up walls, different water-passages, girder and floor systems, the erection of the forms is probably the most difficult part of the job. Very good results are being obtained with a 1:2:4 concrete mixture for the foundation and wall, and a 1:1½:3 mix for the columns, floor system, and various parts that it is desired to make especially water-tight.

DISCUSSION

MEMBER: With the completion of the Calumet sewer and pumping station, how nearly complete will be Chicago's sewerage system?

L. B. BARKER: There will probably be other interceptors built, especially to relieve the condition of the Chicago river, although the Calumet sewer completes the diversion of sewage from the lake. An interceptor is now being built along the west bank of the Des Plaines to relieve the condition of that river, which is a nuisance at times of low water.

WM. KRAMER: Would there be any additional water coming from the lake?

L. B. BARKER: No. The Calumet Sag channel will have a flow of 2000 cu. ft. per second, part of which will come from the Calumet river and the balance from the lake. However, the flow in the main channel at Lockport will remain the same, as the amount received from the Chicago river will be correspondingly reduced.

The Sanitary District is now negotiating for a site near the Calumet pumping station to be used for a treatment plant, where the sewage coming to the pumping station may be treated before it enters the Sag channel. Plans are being made for a treatment plant for the Des Plaines sewer. These should relieve the condition in the canal considerably.

WATER SUPPLY AND SANITATION AT CAMP CUSTER, MICHIGAN

BY SAMUEL A. GREELEY

This paper is based on the writer's work during 1917 and 1918 and covers operating features which have developed with the use of the camp. The work was started on June 13, 1917, when the writer was instructed by the Construction Division of the Army to proceed to Battle Creek and to make surveys, borings and other field investigations for water supply, sewerage, highways and railroads. At that time a divisional cantonment for 36,000 men was projected. The work was carried out during the construction season, so that troops were received beginning the

early part of September. Final construction however was not completed until cold weather. The total construction cost of the 1917 work was about $8,300,000.

The original reservation included an area of approximately 6200 acres within which there were built 1339 buildings divided as follows: Barracks, 269; lavatories, 333; officers' quarters, 116; stables and sheds, 239; heating plants, 42; hospital buildings, 76; miscellaneous, 264. These buildings extend along a bow shaped line with a concrete highway extending the entire length of about 3.5 miles. There is a remount station having a capacity for about 10,000 animals. In August, 1918, it was decided to add a sufficient capacity to the camp for about 14,000 additional troops amounting to an extension of 40% of the original construction. This work was carried out through the fall of 1918, the total construction cost of the 1918 extension being about $3,000,000. In this extension there were added 723 buildings, divided as follows: barracks, 113; huts, 418; lavatories, 59; mess halls, 35; kitchen bldgs., 12; store houses, 11; stables and wagon sheds, 18; hospital buildings, 13; miscellaneous, 44. In the extension no plumbing was provided in the barracks so that the number of service connections was less than the original camp in which water was supplied to practically every building except wagon sheds.

The work included the selection of a source of water supply, the design of the works necessary to develop the source of supply and the application of typical Washington details of the distribution system to local conditions. It was necessary at the outset to build up a sufficient engineering organization to plan, lay out and supervise the work and in particular to provide all necessary temporary water supplies and facilities needed by the construction force. During the 1918 construction, camp sanitation was of particular importance due to the prevalence of influenza throughout the country. This feature of the work therefore received special attention.

The site of Camp Custer is on rolling upland along the Kalamazoo river about five miles west of Battle Creek, and the soil is a typical sandy glacial drift ranging from fine sand to coarse gravel with practically no clay. This glacial drift is from 50 to upwards of 100 ft. thick and overlies rock formation. The topography is extremely uneven. The occupied portion of the reservation stands from 50 to 100 feet above the Kalamazoo river which flows in a westerly direction along the northern part of the reservation. The drainage area of the river above Camp Custer is about 900 square miles. The summer flow is comparatively high due to the large storage of rainwater in the sandy soil. Records do not indicate extremely high flood flows.

The time available for selecting a source of water supply was very short. Four principal sources were investigated as follows:

A filtered water supply from the Kalamazoo river. A connection with the Battle Creek city water works about five miles distant. A supply developed from small lake adjacent to the camp. Wells in the vicinity of the camp.

It soon became apparent that if an adequate well water supply could be secured it was likely to prove the most satisfactory. The Kalamazoo river supply, while ample in quantity was polluted with the sewage of Battle Creek and other towns and could not have been used without filtration. This was not considered feasible on the grounds of both cost and time of construction. The use of the Battle Creek water supply would have required an enlargement of the existing pumping station and the use of water from Goguac lake which was not considered safe without filtration. The yield of the small lakes in the vicinity of the camp was barely adequate and would have required the construction of dams and controlling works at their outlets. All surface water supplies would have called for a safe control and policing of the water sheds to guard against the danger of poisoning by enemy agents. It was therefore determined to make a careful search for available well water.

The Marshall sandstone is a water bearing formation underlying the glacial drift at varying depths and extending in the form of a ring within the lower peninsula of Michigan. There were a number of wells in this formation in Battle Creek. The geological maps indicated the southerly limits of the Marshall sandstone to be near Battle Creek and there were no wells reaching this formation near the camp site. It was therefore necessary to make borings in order to locate the Marshall sandstone near Camp Custer. The first borings were put down along the Michigan Central R. R. just north of the occupied portion of the reservation. In these borings no rock was encountered. It was therefore found necessary to cross the Kalamazoo river north of the camp where a sandstone formation some 50 ft. thick was located and a 6-inch test well yielded 600,000 gallons per 24 hours during a 48-hour test.

Owing to the short time available, it was necessary to outline the general features of the design of the water supply and to start plans before final tests of the wells were available. On July 5 the field work was sufficiently advanced so that detailed plans could be started. These were completed in pencil and bills of material were made up by July 16. The finished drawings were completed July 20, or in 16 days.

The designs included a line of eight wells 200 feet apart, each well connected to a cast iron main extending the entire length of the wells and passing through the pumping station where two 12-ft. cast iron risers, 20-in. diameter were set up for air chambers. From the top of these risers, vacuum pumps drew out the air and lifted the water from the wells to the pumps.

The suctions of the pumps were connected to this same collecting main and delivered the water to storage tanks in the camp about 4000 ft. away and across the Kalamazoo river. The wells were drilled with a 10-in. steel casing extending through the glacial drift and penetrating 8 to 10 ft. into the sandstone. A hole 8 to 10 in. in diameter was then drilled entirely through the sandstone, making the total depth of the wells from 110 to 120 ft. The static level of the water in the wells was from 10 to 15 ft. below the ground level. The casings were cut off at an elevation of approximately 805, which was about 7 ft. above the static water level. An 8 in. wrought iron pipe 40 ft. long was then hung inside the 10 in. casing and connected up air tight to the suction piping.

Starting at elevation 805, the suction lines from the individual wells and the main collector were built in excavation permanently sheeted and not back filled. This suction line rose gradually and slightly to the pumping station so that the center lines at the pump were set at elevation 806. This elevation was fixed as close to the water level in the wells as possible and still to keep the motors safely above high water in the Kalamazoo river. The center lines of the pumps are thus about 8 ft. above the static water level in the wells. It will be observed that the design called for a comparatively long suction line amounting to about 1600 ft. along the greatest length. It was felt desirable to keep this piping in open trench so that it could be quickly got at in case of air leakage. The suction pipes were covered with 2 feet of hay and 1 foot of earth as protection against cold weather. The suction lines from the wells to the pumps ranged in size from 10 to 20 in.

The pumping station equipment comprised originally three horizontal motor-driven centrifugal pumps each with a rated capacity of one million gallons per day, two vacuum pumps each with a capacity of 50 cu. ft. of free air per minute and two liquid chlorine apparatus. The pumps discharged through a 12-in. force main across the marshy land bordering the Kalamazoo river and under the river to four settling tanks, each with a capacity of 200,000 gallons. These tanks were set on a hill some 100 ft. above the camp and sufficient when full to give a pressure under normal conditions of 20 to 30 lb. throughout the camp. Just below the tanks a booster pumping station was built comprising 7 pumps of assorted sizes so that pressures could be boosted with different rates of consumption and an economical use of the pumping equipment.

The distribution system comprises 15 miles of 6 to 12 in. wood stave pipe, laid with driven joints with cast iron fittings. These were provided with bells ground to fit the spigot end of the pipe in a driving fit. During the 1918 extension about 10 additional miles of wooden water main were built, and a more satisfactory

method of making connections with cast iron fittings was adopted. This consisted in pouring lead joints around a plug or template to form a bell to just the right shape and size to take the spigot end of the wood pipe in a driving fit. Troubles from leaks at wood to iron connections were very largely reduced by this method. The only cast iron pipe used in any part of the work was about the pumping station and river and for special fittings and connections in the distribution system. Service pipes were all galvanized wrought iron.

Great care was taken to secure an air tight suction line from the wells to the pumps. In this work, wrought iron pipe with screw joints, Universal pipe with bolts and bell and spigot pipe with lead joints were all used. Great care was taken with each joint, and with the alignment and bedding of the pipes to prevent settlement. After the first tuning up of the suction line there has been no trouble from air leakage.

From the pumping station to the river a 12 in. line of Universal pipe with bolted joints was laid below ground water level. Under the river two 12 in. lines were laid, one of Universal pipe with bolted joints and one of bell and spigot pipe with lead joints. The former was connected up loosely on a platform across the river and lowered in one piece into place in a trench in the bottom of the river. This proved to be the quickest method of getting one line of pipe into service. The bell and spigot line was put down later, the joints being calked under water with lead wood by a diver. Both lines have given satisfactory service. From the other side of the river, a 12-in. wood stave force main extends to the tanks on the hill.

Drilling of wells was started on July 19 with two machines. Shortly a third machine was added. The drilling was practically completed on Sept. 9, but only two were actually connected to the pumping station. These however, were sufficient to supply the camp with water on that date. The pumping station, river crossing and other work were finally completed on Dec. 5. During the 1918 extension, pipe was first received on Sept. 16 and water was first turned into the new work on Nov. 6. The work as a whole was completed about Jan. 22, 1919.

When the 40% addition was planned in August 1918, tests had been made on the eight wells indicating a yield from each at the rate of 6,000,000 gallons per 24 hours. It was therefore unnecessary to drill additional wells but the pumping capacity of 3,000,000 gallons per day was extremely limited. It was therefore decided to add three new pumps to the well station and to build a double 12-in. force main from the pumping station to the tanks. Two of the new pumps were motor driven with capacities of 1,500,000 gallons per 24 hours and the other pump was gas-engine driven with a capacity of 2,000,000 gallons. This was put in to

guard against possible interruptions in electric service, one having occurred during the summer of 1918 of several hours duration.

The water supply from the camp wells is of unusually low bacterial content, and is absolutely safe from a sanitary standpoint. It is however, a comparatively hard water with some traces of iron. The total solids run somewhat above 300 parts per million of which the sulphates comprise 80 to 90 parts. For use in the central heating plant it has been found necessary to soften this water, but it has not been considered desirable from an economic standpoint to soften the entire supply.

The principal operating feature is that of water consumption. The camp was originally planned to supply an average of 55 gallons per capita per 24 hours, which for 36,000 men amounted to about 2,000,000 gallons per day. It was not originally intended to build central heating plants, and as they have no return system they increase the daily water consumption by about 600,000 gallons during normal winter weather. Theactual consumption at Camp Custer under a normal load has ranged from 2,000,000 to 2,500,000 gallons or from 45 to 80 gallons per capita per 24 hours depending upon the number of troops at camp.

Comparative water consumption statistics as regards various camps indicate that Camp Custer is amongst the higher users of water. In considering this matter, the relative per capita lengths of wood stave pipe of each different make in the camps should be compared; also, the type of wood-to-iron joint and other factors affecting pipe leakage. It does not appear in any event that the consumption is excessive. The maximum daily rate of consumption occurs in the early morning and amounts to between 5,000,000 and 6,000,000 gallons. Records of consumption are shown in Table I.

Progress is an essential phase of cantonment construction. During the 1918 extension, a special progress department was organized which proved exceedingly helpful. In no other way was it possible to secure an unbiased estimate of progress of the various divisions of the work as the special interests of each division engineer in his own progress could not be entirely eliminated. Daily reports were turned in regularly to this department and were summarized into a daily bulletin showing the work done to date and the necessary rate of progress in the future to complete the work within the agreed time. During the 1917 work on the original camp, water mains were built at a net rate of 730 ft. per trenching machine gang per day. In the 1918 extension, the average rate of construction was only 342 ft. per trenching machine gang per day. The difference was due to difficulties during 1918 in securing fittings and in keeping the trenching machines in working order. As a matter of fact, during the 1918 work, the

trenching machines were out of commission about one-third of the time.

To maintain progress it was absolutely necessary that the force of some 2500 civilian workmen should be kept healthy and free from influenza. On this account a sanitation department was organized Oct. 1, 1918, and a detailed sanitary policy inaugurated. At that time as many as 3000 meals per day were being served at camp and nearly 1500 men were being housed in temporary barracks. The care of these men devolved upon the sanitation department. It was only by the strictest attention to detail that satisfactory results were obtained. Matters of personal hygiene, washing and steaming of dishes, keeping windows open at night, physical examination of mess hall employees and the like were attended to regularly. The heartiest cooperation was secured from the contractor as soon as he found that the healthy condition of the men assisted him materially in maintaining his labor organization and as a matter of fact largely affected the daily application for work.

During the scramble of the 1917 work the routine was not handled to develop easily into record plans and reports. In 1918 this matter was taken up early and all progress reports and plans pointed toward finished records. A detailed report of all phases of the work was made by each division engineer with statistics and summaries of essential facts. Record plans 20x28 in. were made of the various groups of work.

Of the water supplies for the 16 National Army Camps, 9 are ground water supplies, and 7 are river supplies, of which 5 are filtered. The 4 middle western camps (Custer, Dodge, Grant and Sherman) have ground water supplies.

Camp Custer Water Consumption

Month	Av. Population	Av. Gal. per capita per 24 hrs.	Month	Av. Population	Av. Gal. per capita per 24 hrs.
1917			May	29500	64.5
November	21000	64.0	June	35000	54.3
December		81.0	July		
1918			August		
January	24000	87.5	September	33000	
February	23000	91.3	October		
March	18000	111.0	November		
April	26000	77.0	December		

THE BLOOMINGTON WATER WORKS

BY C. C. WILLIAMS, SUPERINTENDENT OF WATER WORKS

The original plant was built about 1875. There was a small steam pumping plant with a 40-ft. open well sunk 48 ft. to the top of the 12 to 16-ft. bed of water bearing gravel. A pipe was put into the top of the gravel and there was sufficient head on the water to cause it to rise up to nearly the top of the well. A standpipe was installed with a 10-in. line to supply the business district. But the water receded and a new well was put down that was used for about ten years. It was found that the water had then receded and they started a new system, with air-lift pumps and tube wells.

This reservoir was built in 1903, and is reported to be the largest piece of reinforced concrete without expansion joints built at that time. There are some expansion joints in it now, however, because about six years ago we cleaned it out and left the sun to beat down upon it, which caused a rupture of the floor. The reservoir is 300 ft. across, with an average depth of 20 ft. in the middle and 15 ft. at the sides. The joint across the bottom is patched and there is no great amount of leakage.

In 1909, Mr. Morgan, of Chicago, was engaged to look over the situation and the result of his investigation warranted the expenditure of considerable money in developing a new supply. They ran a series of test wells for probably four to five miles north, through the middle of the valley. They reached the conclusion that this would be a good supply, and put in a new plant, doing away with the air-lift system and putting in a well with a motor-driven centrifugal pump at the bottom.

There were three wells, 12 ft. diameter. Then four wells were driven in the bottom, with screens within suction limits of the pump. These were connected to the pump and piped to the reservoir. This plant worked out fairly well.

We have gone ahead with the present system of wells and are constructing one now west of the water works. Last year, we completed a well 20 ft. diameter and 65 ft. deep. This has 10-in. perforated pipes which we drove down 28 feet below the bottom of the pit. They have ¼-in. holes and are connected with the suction pipes and discharge into the reservoir. The pump has a 2000 gallon capacity, 150 ft. head, and a 100-h.p. motor. We have a centrifugal motor-driven pump for direct pressure. You may question the advisability of installing that apparatus along with high duty pumping engines. But it was felt that we should have a reserve unit that would take care of any emergency and as there is an electric light plant connected it was decided that centrifugal pumps would be the best proposition. That pump is 4200 gallons a minute, against 231 feet head, and has showed 81% efficiency.

We have a four million gallon high duty pump and also a six million gallon pump.

The water here is very hard, which accounts for numerous broken gates and we deemed it advisable to purchase a valve-inserting machine which takes out and puts in valves under pressure. We have about 5500 services, all metered. It is hard to keep the meters in repair, on account of the mineral content in the water, and the city has found it advisable to establish its own meter repair shop, but the meters belong to the consumers. I think the city should also own the service pipes and meters and set the meters at the curb as the meters are now set at any place where the consumer sees fit to put them.

THE SEWAGE DISPOSAL PROBLEM IN CHICAGO

BY C. D. HILL

Sewage disposal in Chicago is by the dilution process. The raw sewage of Chicago and its environs is discharged either directly into the main drainage channel of the Sanitary District of Chicago, or indirectly by means of the Chicago River, its branches, or other adjuncts of the drainage system. None of the sewage from the territory extending from the northern limits of Cook County to the state line of Indiana is discharged into Lake Michigan, with the exception of that from a portion of the city of Evanston, where intercepting sewers are now being constructed that will divert this sewage from the lake to the North Shore Channel, and with the exception of sewage-contaminated water from the Calumet river. The Sag Channel, which is nearing completion, and the Calumet intercepting sewer system, now under construction, will eliminate this source of contamination. There still remains a very serious source of contamination from the sewage from the municipalities of northern Indiana bordering on the lake.

The completion of the present projects would seem to provide a complete solution of the sewage disposal problem, but, because of the growth of the city and the changing conditions, new projects and new methods will be needed before the present works are fairly completed.

The Chicago river extends for a distance of less than a mile from Lake Michigan to the junction of the north and south branches. The surrounding territory is a low flat plain and in times of flood the south branch of the river was formerly continuous with a corresponding branch of the Des Plaines river, so that in early days in flood times boats might pass to the Desplaines river and thence down to the Illinois. In the extreme southern part of Chicago is the Calumet river, which drains a considerable portion of northern Indiana as well as northeastern Illinois. The

river lies in a low marshy plain and at times of flood has been connected with the waters of the Desplaines through the Sag.

The connection between the Chicago and the Desplaines rivers was made the location of the old Illinois and Michigan canal which has been paralleled by the main channel of the Sanitary District of Chicago. The connection between the Calumet and Desplaines rivers was made the location of the old feeder canal which supplied water to the summit level of the Illinois and Michigan canal and is the location of the Sag channel which is now being constructed to connect the Calumet river with the main channel.

When the first sewers were built, in 1855, the city extended two miles north and two miles south of the Chicago river and two miles west of the lake. These first sewers all discharged into the river, or its south branch. Later, and prior to 1890, other sewers were built, all of which discharged into the river or its branches, with the exception of sewers in 12th St., 22nd St. and 35th St., which discharged into the lake. During the latter years of this period suburban villages north and south of the city, which have since been incorporated into the city, constructed sewers discharging into the lake, although so far as it was practicable all suburban villages discharged sewage into the river or its branches. From the beginning of the construction of the sewerage system it was understood that this method of disposal of the sewage would result in a foul condition of the river. Our first city engineer, Mr. Chesborough, considered various remedies. One was a canal across the city from the lake to the south branch, approximately along 16th St., and another was a conduit along Fullerton Ave. from the lake to the north branch. This latter was built in 1872. It was intended that water should be forced through these passages from the river to the lake, thereby causing an inflow of water through the main river.

Mr. Chesborough also considered discharging the water from the south branch of the river into the Illinois-Michigan canal, then recently completed. The summit level of the canal at its connection with the south branch was 5 or 6 feet higher than the river. The plan was adopted but by the time it was put in operation the river had become so foul and the capacity of the pumps was so small that the dilution of the sewage was insufficient to produce any perceptible effect. In 1865 the legislature authorized the city to deepen the bed of the canal along the summit level so as to produce a steady flow by gravity from the river through the canal. But soon after the completion of this project it was found that the flow was insufficient. Under a law passed in 1881 a large pumping station was built at the junction of the river and the canal; this was in operation from 1886 until 1900. The pumps had a capacity of about 50,000 cubic feet per minute. The effect was

to prevent the flow of water from the Chicago river into the lake, except in times of severe rains. It produced very slight dilution of the sewage, the river being very foul at all times.

In 1885, the year before the pumps were put in operation, an unprecedented rainstorm produced a flood which caused the Desplaines river to overflow into the south branch. At the same time a large flood came down the north branch and the combined floods flushed the Chicago river and both branches, carrying a vast amount of filth into the lake. As a result a water supply and drainage commission was appointed, headed by Rudolph Hering. The commission recommended the construction of the Sanitary District channel and its adjuncts, substantially as it now exists. Its recommendations were incorporated in an act of the legislature in 1889. Work was started in 1890 and the main channel finished so that water passed through it in 1900. Since then the limits of the original district have been extended north to the limits of Cook County, and south for several miles beyond the city limits.

As a result of the annexation of territory in 1889, the area of the city was increased from about 40 square miles to nearly 200 square miles. The development of the annexed territories north and south resulted in the construction of additional sewers emptying into the lake and a largely increased flow through the sewers previously constructed. The city continued the policy of building sewers in the suburban districts discharging into the lake, although at the same time the Sanitary District was spending money to divert all sewage from the lake. In 1896 the city adopted the policy of constructing intercepting sewers along the shores of the lake so as to divert all sewage from the Lake and discharge it into the Chicago river or its branches. This policy, however, was limited on the south side to 87th St., that being the southern limit of the Sanitary District at that time. South of 87th St. sewers have continued to be built which discharge directly into the Calumet river.

After the extension of the limits of the Sanitary District the sewage from the municipalities north of the city was collected by means of an intercepting sewer and brought down to the northern limits of Evanston and there discharged into the North Shore channel, which is a prolongation of the north branch of the river. This channel has a connection with Lake Michigan at Wilmette, through which water is pumped from the lake, thereby producing a flow which dilutes the water of the north branch. Intercepting sewers are being built in Evanston to divert its sewage from the lake to the North Shore channel.

Work has been in progress for some years on the Sag Channel which will connect the Calumet river with the main channel of the Sanitary District. The channel is necessarily small in capacity, while the storm flow of the Calumet at times is very great.

This makes it necessary to divert all sewage from the Calumet river, and intercepting sewers are now being built which will discharge into the Sag channel just below the connection with the river.

The act providing for the construction of the Sanitary District channel, required 300,000 cubic feet of water per minute to pass through the channel for the purposes of dilution at the time the channel was first opened, and 600,000 cubic feet per minute when the population of the district should increase to 3,000,000. The channel as originally built through the rock section had sufficient capacity for this maximum flow and the earth section has been widened so as to provide for the maximum flow. When the channel was first opened a permit was granted by the United States authorities for a flow of 250,000 cubic feet per minute through the Chicago river. This was supposed to be the maximum without interfering seriously with navigation. Since then the river has been deepened and straightened and in some places widened so that with a maximum flow there would be little, if any, interference with navigation. The Federal authorities, however, insist that the limits of the original permit still apply and that there is serious objection to permitting an increase because of the danger of lowering the level of the lake. The fact that this level today is considerably higher than it was in 1900 when the channel was opened does not appear to affect the argument.

The experience of the past 15 years indicates that the rate of dilution recommended by the commission is barely sufficient to provide for the sewage from the population of the district. This rate, however, did not take into consideration the gross pollution from industries, and the condition of the water in the channel for the past few years has not been satisfactory, principally because of the vast amount of filth discharged from industries and particularly from the stock yards district. The pollution of the water discharged into the Desplaines river and Illinois river is sufficient to justify complaints from residents along their borders. This is in spite of the fact that at times a larger flow is maintained than was contemplated under the terms of the permit from the Federal authorities. There is serious danger that the Federal Government will not permit the increased flow that is needed and may indeed restrict the flow to an amount that would be entirely inadequate.

These conditions have led to numerous negotiations with the Federal authorities and to the instigation and prosecution of litigation, but no results have been obtained either from the negotiations or from the litigation. At the same time the Sanitary District of Chicago has made continuous studies of the problem, particularly with respect to various methods of sewage purification that might be installed in case the Federal Government did not permit the necessary dilution. These studies are appropriate even

though the Federal Government should permit the maximum flow through the channel, for the reason that the time is approaching when the population of the city will exceed that contemplated by the commission which recommended the present works. The Sanitary District has made a series of investigations as to the treatment of industrial waste and particularly the waste from the stock yards district. Definite conclusions have been reached as to the method of treating the latter waste and negotiations are pending as to allotment of the cost of establishing and operating such purification works.

The situation today is critical. The Federal Government may restrict the flow from the lake so that it will be impossible to dilute the sewage to the extent required by the act of 1889. Under this condition the State would be justified in objecting to the discharge of the grossly polluted water from the canal into the Desplaines river, and requiring the construction of supplementary works for treatment of the sewage. To build new treatment works, that would purify the sewage sufficiently so that with the limited dilution of lake water the effluent would not constitute a nuisance, would require years and would cost so much that it would be necessary to obtain special legislation.

There is a lack of appreciation on the part of the general public in Chicago of the seriousness of this situation. Few people realize the opposition of Federal officials to the operation of the channel in accordance with the original plan, and fewer realize the opposition to Chicago from other cities along the Great Lakes. This opposition is due largely to a mistaken notion as to the effect of the flow of water through the channel upon the level of the lakes. If we should obtain from the Federal Government permission to operate the channel at its full capacity, it will be difficult to make the people understand that, because of the growth of population and the consequent increase of pollution of water, it will be necessary to install auxiliary purification works, and once more we will repeat history by showing by actual conditions the inadequacy of present methods long before new works can be installed.

It should be made plain that there has been made no serious mistake in the successive steps through which the sewage disposal works of Chicago have evolved, except the mistake of procrastination. Each step has been logical and reasonable, and to have attempted other methods would probably have been unwise. At the time the present works were planned there was a contention on the part of a few progressive engineers that the construction of a large canal for dilution was unwise and extravagant and that a much better plan would be to build sewage purification works. If such a plan had been followed the method of purification adopted would have been obsolete before the work had been fairly started,

and if Chicago could have changed its work as often as the engineering profession has changed its opinion as to the most effective method of sewage purification, the works would have undergone a continuous process of rebuilding. It is possible that the best method of sewage treatment has not yet been developed. However, we are fast approaching the day when some method supplementing dilution must be adopted.

GARBAGE COLLECTION AND DISPOSAL

BY S. A. GREELEY

Refuse is the solid waste resulting from the life of the community, distinct from sewage. It is of different kinds: house refuse, public refuse, stable refuse, industrial refuse, and so on. The house refuse includes garbage, ashes, rubbish and tins. It is advisable to have a fairly general terminology so that statistics will be more generally useful. I use the word garbage for kitchen and food waste, ashes for the residue from fires, and rubbish to include old shoes, boxes and paper. Tins include tin cans and tin and metal ware. Stable refuse or manure is important because of the fly factor. The problem should be viewed from four different angles: 1, house treatment; 2, collection; 3, transporting to a point of disposal, and 4, the final disposal.

In the smaller towns the transfer phase is not so important, but it should be considered, particularly when the disposal plant is at some distance. Public opinion is generally directed first toward disposal, but the other phases are equally important. Collection is always the most costly part, costing two or three to five times as much as the disposal. House treatment is controlled through city ordinances and should be planned in relation to the collection and disposal. The ordinance should state whether the householder is to be required to separate the refuse into classes and should designate the type and size of the can with reference to easy handling.

Collection functions largely around the wagons, and has both a sanitary and economic standpoint. Wagons must be planned with reasonable regard to economy. As the time of haul from point of collection to the point of disposal should be kept at a minimum, a large wagon should be used which makes only one or two trips a day. A small wagon making many trips a day multiplies the unproductive time. The wagons should be built for easy unloading, of proper height and properly covered. One of the most successful covers is a canvas arched over the wagon and covering the refuse while material is being loaded.

Transfer begins after the collection has gathered the refuse to a central point. There is first the construction of a transfer

station where wagons may be hitched up to a trailer, or some other method used for reducing the cost of a long haul of the garbage collected from house to house.

Disposal embodies many methods. Land disposal is first, by burial or dumping. Dumps are an important feature, because they are so ever-present, and some classes of refuse are always needing to be dumped. Another method is by feeding to hogs. The time honored method in England has been by burning, but in a number of towns the garbage has recently been separated and part of it fed to hogs. Disposal of rubbish is by sorting out the valuable portions, waste paper, old shoes, etc., and burning the residue. Burning both garbage and rubbish has been practiced to a large extent throughout this country. The reduction method is also applicable to garbage, which is thus separated into water, grease and tankage.

Seattle has a mixed collection with disposal formerly at three or four incinerators, but when I was there last February the incinerators were being used as garages and all the refuse was being disposed of on dumps. At Galesburg, a few years ago, an ordinance was enacted regulating the house treatment and giving some information as to the method of collection. A new collection system was started and two areas on each side of the town were secured for the burial of garbage, if necessary. But it was planned to transfer the garbage to farmers for feeding to hogs, with burial in case of emergency. At Winnetka each house is given one collection per week free of charge; if the owner desires more, he pays for the extra service. This system is to the advantage of the whole town and it pays for itself. New York has installed motor trucks of 25 cu. yards capacity. At Maywood recently, they were burying their refuse adjacent to a high school, and there had been many complaints on account of the conditions and the flies. The site was not abandoned but improved methods of burial were undertaken.

At Louisville, in 1917, the Woman's City Club went into the garbage disposal problem and asked me for some direction in their efforts. A very complete study of the situation was made. There were ten committees, covering financial aspects, state and municipal laws, methods of house treatment, collection, operation of dumps, etc. The two committees on house treatment and collection divided the city into ten districts, and made a house to house canvass to see what was being done by the householders, what kind of cans or baskets were being used and what work was being done by the collection wagons. It was decided to dispose of the refuse by feeding to hogs, which required a change from mixed to separate collection. It was not easy to get a city of 250,000 people to separate their garbage after a system of combined house treatment, but it was done by dividing the city into school districts and by using the women in the various parent and teachers asso-

ciations to make house to house canvass in their districts and instruct the householders how to carry out the provisions of the ordinance. A temporary transfer station was built and garbage disposed of to a number of farmers.

THE PLACE OF DRAINAGE UNDER THE CIVIL ADMINISTRATIVE CODE OF ILLINOIS

BY G. W. PICKELS

One public improvement which needs all the backing which the Society can give it is the reclamation of the swamp and overflowed lands of the State. The State must help in this work just as it is helping in the construction of highways, and this Society can assist by pointing out to the proper state authorities the state's responsibility in this matter and urging that something be done. The question arises as to just who are the proper authorities and what the status of drainage reclamation is under the present state administrative organization.

The 50th General Assembly in 1917 passed an act entitled "The Civil Administrative Code of Illinois" under which all the business of the State is carried on. This provides for the establishment of nine departments: finance, agriculture, labor, mines and minerals, public works and buildings, public welfare, public health, trade and commerce, and registration and education. The duties of each department are specified; but nowhere is the word "drainage" used, and no definite provision is made in any department for land reclamation by drainage.

1. *Aid Given by the State.* From the time the swamp and overflowed lands came into the possession of the State as a gift from the Federal government, the state legislature has tried by the enactment of laws to make it possible for those who bought the land to reclaim it. Since there was no provision in the state constitution for the enactment of drainage laws, and since the construction of ditches or drains across lands without the consent of their owners was contrary to the common law, the acts of the General Assembly up to 1870 were declared unconstitutional. In that year and again in 1878, the constitution was revised and a drainage provision was included. Since 1870 there has been no General Assembly which has not passed some drainage act or amendment whereby the organization of drainage districts might be more readily carried out. Since 1870 there have been 114 acts or amendments made to the drainage laws.

It would seem, with all the time and effort that have been expended on them, that our drainage laws would be thoroughly satisfactory and effective; but as a matter of fact, drainage dis-

tricts have been organized under the greatest legal difficulties. However, this condition of affairs cannot justly be charged to the State, and the blame must be borne in great part at least by those who desired legislation but did not know definitely what they wanted. The result of this patching process is that our drainage laws are complex and inadequate to meet the present needs.

Mr. H. F. Bain, the first Director of the State Geological Survey, in his 1906 report to Governor Deneen, called attention to the need of drainage investigations in the following words:

"It is also very important that a survey and investigation of swamp and overflow lands in the State be made, together with a study of the measures necessary to their reclamation. Despite the efforts of the local boards, there remains considerable unreclaimed land which is capable of becoming as productive as any in the State. Destructive floods in a single year wipe out property worth more than the whole cost of proper works to control certain rivers. Any works constructed to remedy these defects should be built according to plans taking into account the whole valley and the flood action of the whole river. Before such works are attempted, whether by State or local boards, the subject should be thoroughly investigated and the area of land to be benefited determined by accurate surveys at the same time that the proper methods of river control and costs are studied."

As a result of this recommendation, the 45th General Assembly appropriated $15,000 for an investigation of the overflowed lands by the State Geological Survey. The Internal Improvement Commission of Illinois and the U. S. Department of Agriculture cooperated with the State Geological Survey, and a State Committee on Waterway Reclamation was formed. Surveys were started in 1907 and continued intermittently till 1915. The river basins surveyed were the Little Wabash and Skillet Fork, the Embarrass, the Big Muddy, the Kaskaskia, the Spoon, and the Pecatonica.

Few districts, however, were organized as the result of this state aid. The failure of the individual communities to make use of these plans was not due to lack of interest, but to the fact that in order to carry out the plans, organization on a large scale was required, and this organization could not be effected under the existing laws. Although the State offered the above incentive to drainage, it did not contemplate any assistance in the carrying out of the plans. Drainage was still looked upon as a local matter, of direct benefit only to those individuals whose land would be improved thereby and rendered fit for cultivation, and was not considered in a broad way as being of great benefit to the State itself. This is the keynote of the entire subject, and explains why no direct provision was made in the code of 1917 for reclamation by drainage.

In most localities the individuals most concerned have done about all they can do of themselves. They have availed themselves of the laws for the establishment of drainage districts and have succeeded in draining a considerable portion of the wet lands.

At the present time the question of greatest moment is the provision of the outlets necessary for the surplus water emptied into the outlet stream. This involves the cleaning and straightening of the river channel, and the construction of levees providing a floodway sufficient to carry off all flood waters. This is too large a proposition for the individual district to handle due to cost, inadequate laws and difficulties of organizing on a sufficiently large scale to provide an outlet throughout the drainage basin. The act of June 27, 1917, enables adjoining districts to combine for the construction of joint outlets; but the difficulty has been in getting the commissioners of the several districts to agree as to the extent of the work necessary and as to the relative proportion that each district should have to pay. This difficulty can be avoided by the appointment of one set of commissioners, which would also increase the efficiency of the improvement and decrease the cost of construction.

Two special acts were passed by the General Assembly in 1917 providing for the organization of the Little Wabash drainage district and the Skillet Fork drainage district. Thus it seems necessary to pass special legislation in order to enable entire river basins to effect a practical organization for reclaiming land by drainage. The flood control bill passed by the 64th Congress, carrying an appropriation of $45,000,000, should prove of assistance to river communities even though it limits improvements to the strengthening and raising of existing levees. The time has arrived when the State should take a hand in the supervision of drainage reclamation. The question arises why the State should be concerned with this work and just what it should do. This brings us to the second point in our discussion as to the State's responsibility in the matter.

2. *The State's Responsibility.* Drainage is not a local affair of benefit to only a few individuals. It is a state and in some instances a government concern. The reclamation of its swamp and overflowed lands is a responsibiilty which was placed on the State by the Swamp Act of 1850, and one which has been side-stepped in one way or another to the present time. It is estimated that there remain to be reclaimed about 2,500,000 acres in Illinois. This land is now of no benefit. When drained and protected from overflow, the land values to the people of the State will be increased at least $100,000,000. The State could make no better investment than this. Not only would the state revenue be increased directly by taxes, but the increased production would be of indirect benefit to the entire State. Reclamation work is usually followed by an increase in the population and a more rapid development along industrial lines.

What is it then the State should do? It should make it practically impossible for an entire drainage basin to be organized

in one district without special legislation in each case. It should aid financially in the control of the principal streams and thus furnish outlets for drainage. It should approve all reclamation plans and thus guarantee the efficiency and adequacy of the proposed improvement. It can assist in the financing of drainage districts by approving and aiding in the disposing of drainage bonds. It should carry on an educational movement in regard to the economic value of all kinds of drainage.

3. *What Department should carry on this work?*—There are two departments of the state administration under which drainage reclamation might be carried out, namely, the department of public works and buildings and the department of registration and education. Several of the other departments might assist in a general way. The department of public works and buildings has the power to exercise the rights, powers and duties of the former Canal Commission, the Rivers and Lakes Commission, and the Illinois Waterway Commission, which were abolished by this act. The Rivers and Lakes Commission took more interest in drainage reclamation than any of the others and was the only one whose duties were definitely stated in drainage matters. Chapter 19, Section 63, of the law establishing this commission reads as follows:

> "It shall be the duty of said Rivers and Lakes Commission to furnish at its actual cost to any person or persons who may be desirous of reclaiming, draining or cultivating any wash or overflowed lands in connection with any of the public waters of the State of Illinois, any and all data which they may have in their possession, showing surveys, elevations, contours, cost of construction of levees, plans therefor, and information and reference thereto, and shall so fully as may be, advise with, aid and assist in any and all enterprises looking toward the reclamation or drainage of lands wherever in their judgment the same may be attempted without detriment to the interest of the State of Illinois, or the public, in any of said bodies of water."

Since the department takes over the powers of the Rivers and Lakes Commission, the above duties devolve upon it, and under these powers, it is justified in taking the initiative in drainage reclamation, and should be held responsible therefor. The department of public works and buildings includes a superintendent of waterways and an advisory board of water resources, composed of five members. The former is the state officer directly responsible, and should carry out plans for the regulation and control of the streams of the State,—to control floods, to provide outlets for drainage, to develop water power where feasible, and to promote water transportation. The duty of the board of five advisors is "to advise relative to riparian rights of the State, and the conservation, use and development of water resources." These duties cannot literally be interpreted to include drainage matters; but this is the only board in the department which could carry on the work of the Rivers and Lakes Commission. However, plans and

recommendations might originate in the department of registration and education, and be referred to the department of public works and buildings for action. I think there can be no doubt but that this is the department which could carry out the work of drainage reclamation.

The duties of the department of registration and education in this connection are: "(1) to investigate and study the natural resources of the State and to prepare plans for the conservation and development of the natural resources, (2) to cooperate with and advise departments having administrative powers and duties relating to the natural resources of the State, and to cooperate with similar departments in other states and with the United States government, (3) to collect facts and data concerning the water resources of the State, and (4) to publish, from time to time, the results of the investigations of the waters of the State to the end that the available water resources of the State may be better known and that the welfare of the people of the State in the various communities may be conserved."

This department consists of a director, an assistant director, and a superintendent of registration. Also a non-executive board of natural resources and conservation advisors, composed of the director of the department, the president of the University of Illinois or his representative, and one expert each in biology, geology, engineering, chemistry, and forestry. This board acting through five or more sub-committees, each composed of the director of registration and education, the president of the University of Illinois or his representative, and the expert advisor qualified in each of the fields of investigation, "shall consider and decide all matters pertaining to natural history, geology, water and water resources, forestry and allied research, investigational and scientific work."

Here again it is doubtful whether "matters pertaining to water and water resources" was intended to include drainage matters; but certainly it is the sub-committee consisting of the director of the department, the president of the University and the engineering expert which should consider the subject of drainage reclamation and submit recommendations to the proper executive department as to the State's responsibility in connection therewith.

Work of a cooperative nature should be handled by some of the other departments. One of the powers of the department of agriculture is "to encourage and promote, in every practical manner, the interests of agriculture . . . . and to promote improved methods of conducting these several industries with a view to increasing the production . . . thereof at the least cost." We are accustomed to think that the higher lands not subject to overflow are drained either naturally or by tile drains. This is not the case. Our agricultural advisors tell us that particularly in the southern third of the State, the general attitude is one of indif-

ference or even of opposition to drainage. The productivity of the land can be largely increased by drainage and scientific cultivation. The department of agriculture should take the lead in an educational movement toward improving the present conditions.

The department of public health can take a part in the work of drainage. One of its powers is "to make examination into nuisances and questions affecting the security of life and health in any locality in the State." Wherever the swampy condition of the land is injurious to the health of the community, it is the duty of this department to investigate and make recommendations which will improve the situation. But the departments directly concerned with drainage reclamation are those of public works and buildings and registration and education. Plans and recommendations might originate in either department, but the former is the one mainly responsible since any construction work would naturally fall upon it.

The present is a very opportune time to urge assistance in drainage reclamation on the part of the State. The superintendent of waterways and the director of the department of public works and buildings have worked out a plan for the construction of the Illinois link in the lakes to the Gulf waterway. The present General Assembly has been asked to pass the necessary legislation so that construction work can be started as soon as possible. Although the principal object of the waterway project is to develop water transportation yet the drainage reclamation which will follow this improvement will add to the health of the State. Money is plentiful, labor is abundant, and the construction of various city, state and government work is necessary to the public welfare.

DISCUSSION

F. W. DEWOLF: The review of the drainage situation in the State as given by Professor Pickels, impressed me as most excellent. The National Drainage Congress in Chicago passed a resolution regarding state direction of drainage work. Following this I wrote to Mr. Shepardson, Director of the Department of Registration and Education, urging action in cooperation with the Department of Public Works, or such steps as might be necessary to bring the attention of the Governor and Legislature to the need for definite authority and suitable funds, in order that some agent of the state might get busy on this matter. I may say that last summer, Mr. Shepardson raised the question in a meeting of the Board of Natural Resources and Conservation, and appointed a committee to review the situation. Later the committee recommended definite steps, but in spite of frequent references to the subject, it has evidently been difficult for Mr. Shepardson to get any action. One possible explanation may have been that the direction of the Department of Public Works was vacant, due

to the death of Mr. Puterbaugh. However, I am assured by Mr. Shepardson that both he and the Governor are giving the matter serious consideration.

E. A. ROSSITER: In keeping with the suggestion in this paper I wrote to Governor Lowden on Jan. 6, as follows:

"For a number of years the drainage lawyers, engineers and commissioners have been trying to modernize and revise our state drainage laws, but the universal opinion among attorneys has been, that they had better let good enough alone; that bad as the laws are, they might be worse. There is no method under our laws that an entire catchment area can be organized into one drainage district and an outlet be properly made to drain the watershed. No engineer, attorney or drainage commissioner can afford to spend time to draft a comprehensive bill to present to the legislature, and it is important that none but the most competent in the business should undertake the work.

"I therefore suggest that provisions be made, whereby the drainage committee of the House, together with the engineering faculty of the State University and two drainage engineers be a special committee authorized by the legislature to prepare a bill, that a sufficient sum be appropriated to pay the expense and salary of each member and clerks during the actual time spent. It seems to me that the laws as to the manner of organizing a drainage district no matter how great or small should be far more simple. That one general law should be enacted and after specifying the various methods of organization that the commission or trustees should all proceed under one set of specifications.

"Further I would suggest that a survey of all the rivers of the State be made with the end in view of creating barge canals of every waterway where possible and if it is feasible to combine the drainage and canal work a double benefit can be derived, inasmuch as when a barge canal is constructed the question of the draining of the immediate vicinity is settled far greater than if the drainage were the only result in view."

This letter was acknowledged and I understand that the matter will be taken up with the Commissioner of Public Works so that there is a possibility that some action may be taken relative to new Drainage Laws for the State. Further, regarding suggested changes in the drainage laws, at every meeting I have attended where drainage laws came up for discussion there was a division of opinion, engineering and legal, the lawyer always advising to let good enough alone.

MR. REEVES: They are considering a new set of drainage laws in Wisconsin, and it might be well to obtain a copy of these so that we may benefit by their investigations.

MR. NEIGHBOUR: What about the extension of jurisdiction over greater territory? From my own experience I find that each catchment area should be a drainage unit. In our county, the Green River territory, the land is very flat and through its course we have four drainage districts with a gap or two between. These gaps are exceedingly detrimental to the drainage districts below, the debris, sand and silt from the unimproved portions, filling up waterways and ditches in the established districts, which necessitates frequent cleaning out.

I heartily approve the idea of making the unit the entire catchment area but under our laws you cannot always obtain what you want. If it is impossible to incorporate the entire catchment area in one district then the commissioners should have the authority to go out of the district and do such work as may be necessary to obtain a proper outlet and such other work in order that water coming in from the high lands may flow freely without danger of a washout. A few years ago we had an outlet ditch which was out of our district. Our attorney told us that we had no jurisdiction so we stopped at our boundary line. After a flood had endangered a bridge and several horses, a vehicle and other things were lost and lands torn up, we went out of the district, bought up a right of way, improved the outlet and took our chances on the legality of so doing.

WATER RESOURCES OF ILLINOIS

BY F. H. NEWELL

Citizens of Illinois have not been accustomed to think of water resources in a large way or give the subject much consideration except in times of extreme drought or flood, or in connection with some local problem such as that of municipal supply, drainage, or restoration of navigation. It is difficult to find in the civil administrative code of the state, the responsibility for initiating or carrying out any comprehensive scheme for the development of these great and necessary resources, and for this reason, if no other, the engineering societies should take a large view of the subject. There are points which are of interest to students of hydro-economics and what is said of Illinois pertains to neighboring states. A study of conditions here has application throughout the vast Mississippi Valley. The uses of the water resources of the state as a whole may be classified into five principal groups as regards their importance to humanity: 1, the development and protection of drinking water supplies; 2, regulation of water in production of food, such as through drainage and flood protection; 3, disposal of sewage and manufacturing wastes; 4, manufacturing and power production; 5, transportation of persons and goods. This last is of least importance, but of great present interest.

As a rule there is more water than is needed for the largest crop production, though there are irregular periods of drought. The useful plants are dependent upon a somewhat limited range of water in the soil and are found to be productive only when the water is adequate, but on the whole rather restricted. That is to say, while in certain soils the food plants may grow when the water in the soil ranges from 8% to 16% yet they do not produce abundantly unless the amount is restricted to, say, 12%. These

figures do not apply to any one plant or soil, but they illustrate the fact that an increase of from 2 to 5% of water in the ground during the fruiting season may convert what would otherwise have been a profit into a loss to the farmer.

While many of the farms do not require drainage, yet nearly every farm has from one to several acres of land which in a wet season has a little more water than is good for the crops. The same amount of labor, seed and care is needed for these acres as for those which are productive, but as they return little or nothing they eat up the farmer's profits. These scattered areas aggregate tens of thousands of acres and tend to greatly reduce the food production of the state. The most striking situations, however, are those where visible swamps, marshes or overflowed lands exist along the streams where rich soil has been deposited by floods during past ages.

As for water supply, we find everywhere that drinking water is taken from small streams or from wells fed by percolation from these streams, and the water from sewage and industrial wastes is promptly returned to the same channels. There is an implicit trust that nature will take care of this refuse, and will purify the water so that the next user down stream may enjoy it. As a matter of fact many of the smaller streams are really open sewers, left in a condition which is not creditable to the citizenship and to our present knowledge of sanitary science. The Illinois river in the upper portion is peculiarly obnoxious as it is the open sewer for Chicago, being in fact the prolongation of the Sanitary Canal. As stated in the report of the board of experts of the Chicago Real Estate Board: "Reliance should no longer be placed upon the discharge of crude sewage of Chicago and its neighboring municipalities into the open channels and waterways leading to the Illinois valley. It has never produced completely satisfactory conditions at Chicago and it never can do so. It has produced unsanitary conditions for many miles."

Water from wells in certain parts of the state contains such a large amount of mineral matter or is so hard as to be unsuited for many purposes, even for the making of steam, without addition of some chemical substances. While much has been done in investigating better sources of water and in water softening, it is incumbent upon the engineer to stimulate the acquisition and publication of up to date information on these matters in order to facilitate the development of many industries.

There are relatively few localities where the fall of the stream is adequate for the economical production of power. The rivers and creeks have usually slight fall and water power can be developed only by building dams of relatively low height. The objection to these is that water is ponded back and may injure lands otherwise valuable for agriculture. The most important un-

developed resources in water power are those on Illinois river, rendered peculiarly important because of the increased steady flow assured by the Chicago sanitary and ship canal. This has brought in many legal complications so that full use of the water power which might be developed has been left pending the settlement of legal questions.

The question may be seriously considered whether we can return in part to inland navigation, and—relieved of the opposition of railroad managers—restore the waterways to their best use. There has been a vast amount of literature issued on the subject of the navigation of Illinois river and its improvement, but there are no easily available concise statements bringing up to date the present situation. Most of the discussion is of the nature of arguments for or against a certain way of procedure, presented by advocates of various schemes. The publications available avoid largely the essential features which should be demanded by engineers and economists as well as by the citizens in general by which to judge of the merits of different projects.

Perhaps the best description of the inland waterway projects are given by Prof. H. G. Moulton of Chicago in his discussion on waterways vs. railways, prepared in 1912. He describes the scheme for the Lakes-to-Gulf waterway, also the project of "14 ft. through the valley" and the army engineers' scheme of 8 or 9 ft. depth of navigable water from the lakes to the gulf. The problem of providing a satisfactory waterway is aided and at the same time complicated by the interests arising from the use of the river as a sewer, or continuation of the Chicago sanitary canal, and by the demands of various owners or riparian lands and promoters who are concerned with water power.

While movement of freight on waterways is the most economical means of transportation, yet the saving to the public in this regard is usually more than offset by the loss involved in getting the freight upon the water and off again. The only conditions under which inland water transportation is proving to be more economical than railroad transportation appears to be those where great quantities of bulky material such as iron ore and coal can be handled by machinery. Materials which must be brought by truck or car to terminals on inland waterways, transferred, loaded upon a boat or barge, then unloaded and placed upon a car or truck, are so greatly delayed or involve so many handlings that the cost of these more than balances the saving of cheap water haul. With present conditions of labor, it is this rehandling or terminal cost which adds the greater part of the cost of delivery of the goods.

Before any plan of waterway development is determined upon these matters of economy should be given full consideration, especially those having to do with the provision for municipally owned terminals. While for many reasons it is unwise to urge

delay in starting operations, yet there should be no large scheme entered upon without complete presentation of the necessary information as to the probable use of the waterways and the way in which they can be employed to the benefit of the public as well as of individuals.

SURVEYS FOR THE EXTENSION OF OGDEN AVENUE; CHICAGO

BY R. T. DEVEREAUX

The present Ogden Avenue extends southwesterly from the intersection of Randolph St. and Bryan Place to the west limits of the city near W. 26th St. For many years it has been proposed to extend this street northeasterly to Lincoln Park and the Chicago Plan Commission has made a definite recommendation that Ogden Ave. be extended to a point on the west border of Lincoln Park at the intersection of Center St., N. Clark St. and N. Park Avenue. During the past year the engineers of the Board of Local Improvements have been making surveys and studies to determine the best location for the street and to lay out the street as thus located.

About midway in its course the proposed Ogden Avenue crosses Goose Island, which is a tract of land largely covered with railroad tracks and industries, lying between the north branch of the river and the canal, thus necessitating two bridges. On each side of Goose Island are other railroad tracks, and just east of it the proposed street crosses Halsted St. very close to the intersection of Division St., each of which streets has street car tracks while Halsted St. in particular carries a heavy traffic. At the present time this intersection crosses at grade the tracks of the C. M. & St. P. R. R.

In order to make an intelligent study of the problem so that the street might be located with a view to avoiding obstacles as much as possible, particularly such obstacles as would give rise to very serious litigation, and at the same time to lay out the street so as to make ample provision for traffic and to avoid waste of land by awkward intersections of streets, it was necessary to plat all of the property along and near the proposed line and show on the plat the character and use of buildings and improvements. The proposed street will be 108 ft. wide. It will probably be improved throughout the major part of its length with a roadway 78 ft. wide, and with sidewalks 15 ft. wide on each side. The street will contain car tracks, and the liberal width of roadway will permit the passage of street cars, heavy trucks and rapidly moving automobiles without interference with each other. Where

the street crosses Goose Island and the adjacent railroads it will probably be carried on a viaduct. Elsewhere the street will pass beneath railroads which are or will be elevated.

The Chicago Plan Commission chose Center St. and Clark St. as the most desirable northern terminus and the southern terminus was fixed. It was then necessary to determine a feasible line connecting these ends. To work out the best line, a study map was prepared, showing the property lines, buildings, railroads and other features, throughout the entire length of the proposed street and wide enough to cover a block or two on each side of a straight line connecting Randolph St. and Ogden Ave. with Center St. and Clark St. Fortunately the city possesses a set of insurance atlases on a scale of 1 in.=50 ft. and showing the block outlines and all the buildings and indicating the type of buildings and the purposes for which they are used. From field surveys a skeleton map showing block outlines was constructed and the details of houses and other occupation were filled in from these atlases, making an ideal study map at a minimum of cost. The engineer for the Board of Local Improvements and the architect for the Chicago Plan Commission laid out on the study map all the possible practicable routes, and after weighing their relative merits, costs and attractiveness, they decided on the alignment having the most to commend it. The Chicago Plan Commission, the Board of Local Improvements and various civic organizations have approved the plan.

I will call your attention to a few of the considerations which affect the location of this street. In the first place, a straight line runs through two very large costly churches, a large public school, and a Y. M. C. A. building. The churches might be torn down or moved at great cost, but the public school is an absolute barrier, for under the law of Illinois it is not possible to condemn property which is already public property. This straight line also seemed to touch every valuable building along the route. When the line was broken into a few straight lines and shifted to miss one obstacle, it would surely touch another. Finally a slightly curved location was worked out which misses the two churches, the public school and the Y. M. C. A., and takes in comparatively few costly buildings. It gives feasible crossing at the railroads and the river. It will develop wonderful business centers at intersecting car line streets and especially at Chicago Ave., Milwaukee Ave., at Halsted St. and Division St., and at North Ave and Larrabee St., and it ends at Lincoln Park at the end of a boulevard running north.

Another consideration which it was always necessary to bear in mind was the appearance of corners of buildings which lay close to the line of Ogden Avenue. If the line passes too close to

such a building the building will have the appearance of projecting into the street, marring the effect.

The strip, through which this proposed street will run, lies in one of the oldest parts of the city. All the land records of the county were destroyed in the fire of 1871. The records now used for surveying purposes in such parts of the city are atlases, compiled after the fire, from plats in the possession of various individuals and firms, from deeds and from surveys, but all of these combined can never take the place of the original records. Consequently, when omissions or discrepancies are apparent on the plats, the difficulties must usually be worked out in the field. There are no monuments in this section of the city. Therefore, street lines and interior property lines must be located by a study of the occupation.

Having decided the approximate location of the proposed street, we outlined the subdivision and blocks which should be included in a survey. The next step was to run out these subdivision lines and block lines. The lines were run on offsets from the street lines and checked by a measurement from the offset line to every building facing the street, except those which were clearly set back from the street line. The offset lines were also checked by measuring the occupation on streets which lay at right angles to them. The points of intersection of the offset lines were marked either by cross notches in the walks or by copper plugs with cross marks on them. The distances from cross to cross were then carefully measured and the angles between the different offset lines were each read a sufficient number of times to insure accuracy. Later the lines of every piece of property touched by the proposed street were established and the occupation on these lots was located in the field. In the field work we used steel tapes graduated to feet and hundredths. We used mainly a transit reading to 20″.

The entire survey was closed by latitude and departure. The offset line on Halsted St., from Division St. to North Ave., was accepted as a meridian. The hub at Halsted St. and Division St. was arbitrarily given a latitude of 7900 ft. north and a departure of 5000 ft. east. All the polygons were then closed with reference to this line and this hub, by first closing the large polygon of which this line formed one side. Adjacent polygons of equal size were added to the first one and closed. This was continued until all the six large polygons were included. The small polygons, inside the large ones were then closed, all with reference to the line of Halsted St. as a meridian. When closing the polygons we went a little farther and obtained the total latitudes and total departures of all hubs. These were tabulated and used as co-ordinates in subsequent calculations. Using the values assigned

to the hub at Halsted St. and Division St. gave us positive values for all total latitudes and total departures. This was desired to simplify our calculations.

In plotting, two points which lie close to the ends of the proposed street were accepted as lying on the center line of the drawing. The total latitude and total departure of these points were obtained, and using these values as co-ordinates the equation of the center line was written and the slope of the line obtained, and from this line were laid off lines running north-and-south and east-and-west and spaced ten inches apart (500 ft. on scale 1in.=50ft.). All hubs were then platted from these lines by their total latitudes and total departures. From these the block outlines were filled in, and later, after a more detailed study of occupation, the lot lines and buildings in the blocks were platted.

In the method of performing the computations, this survey differed from most city surveys. The problems were solved mainly by means of analytic geometry. This method lent itself splendidly to solving the problems involved. The total latitudes and total departures of points were used as co-ordinates of the points. The axes were chosen so that all the work lay in the first quadrant.

The line of the Ogden Avenue extension is made up of a series of straight lines. The equations of these lines were written and their intersections with streets and the distances from these intersections to block corners were found. Later the exact size and area of each piece of property taken were computed. In all, the improvement includes parts of 550 separate pieces of property. The legal description of the property to be taken was written and embodied in a resolution for the improvement adopted by the Board of Local Improvements. An ordinance calling for the improvement is pending in the City Council. When this is passed, the usual court proceedings must follow before the work of construction can be commenced.

REFLECTIONS OF A CHICAGO SURVEYOR

BY M. L. GREELEY

The modern foundation construction for the Chicago skyscraper, commonly known as open-well or caisson, has developed some interesting habits in the old buildings built on floating foundations. The business section of the city literally had to be lifted out of the mud by three successive raises of the grade of the street of 3 ft. each. In a deep street excavation I have seen the remains of the former street pavements. The lowest was just planks, laid on the surface which was then only about 5 ft. above the lake level and above the plank roadway; two pavement sof cedar blocks, 3 ft. apart, and then the present granite block pavement, 9 ft.

above the plank roadways. My father has told me of seeing signs placed in a mud hole in the street, "No bottom here," to warn drivers. This was in the days before the grades were raised.

The soil was no better for the foundation of buildings than for the roads, and the weight of the old three and four story buildings was distributed by laying a first course of flagstone, four or five feet wide, which floated on the mud and carried the superstructure of brick and stone. A record of borings at the site of the postoffice is interesting in showing the nature of the sub-soil under the loop district. From street grade down to 22 ft. is back filling and loam; then plastic clay to 29 ft.; very soft moist plastic clay to 55 ft.; at 67 ft., hard brittle clay; at 73 ft., hardpan; at 83 ft. soft clay and at 100 ft. rock. From this record we see that the sub-soil for a depth of more than 60 ft. contains much water and is quite fluid. Foundation wells are sunk sometimes to hard pan but generally to rock. In the latter case to a depth of 90 to 110 ft. As the sinking progresses, the water from this soil for a considerable radius from the caisson seeps into the well, causing the buildings on floating foundations to live up to their names and float.

I made a survey for a 21-story building at the corner of two of the principal streets. Immediately south of and adjoining the site was a 10-story modern steel building on floating foundation. We had the exact width and location of this building in this survey and in one made a year or two earlier. The new building was built on piers in foundation wells sunk to rock. The construction of the superstructure proceeded from the street south towards the 10-story building at the south line. When they came to the last line of steel beams, it was discovered that the space between the south row of columns and the 10-story building was 3½ inches short at the first floor.

The buck was immediately passed to the surveyor on the claim of error in dimensions in the original survey. We proved the accuracy of our survey and found the shortage was due to the movement of the 10-story building towards the new construction, following the flow of water and silt released from under the foundations of the 10-story building. We found on a re-survey that the north wall of the second building south of the new building had moved north 0.07-foot, that there was a space of 0.09-foot between the buildings which had prior to the new construction been a tight joint, and that the 10-story building had expanded 0.10-foot, which accounted for the 3½ inches of shortage.

The south wall of south building, 160 ft. south of the digging, had not moved at all. The 0.07-foot movement was an expansion in the building as was also the 0.10-foot in the building immediately south of the new construction. Neither building showed any cracks or evidence of a breaking away of the side walls from the

front and rear walls. When we reported our findings to the architects we were met with contempt and a refusal to accept our statement of the expanding of the buildings as possible.

Our measurements of the width of these buildings were made in the regular course of our business by two different surveying parties and were recorded in field notes made at the time, at intervals of a year or more apart, and were made without any idea of what was ultimately to take place. We discovered that another surveyor had measurements of these buildings made prior to the new construction and employed him to remeasure them for us without telling him what the trouble was. He reported that he made the buildings about one inch wider than formerly. He confirmed our measurements exactly and proved our contention. We were thus absolved from the necessity of paying for cutting off twelve steel beams on each of the 21 floors, or of cutting into the brick.

In another case we ran out the face of an old building on floating foundations and producing it each way marked it on buildings that would not be disturbed by building operations. After the caissons had been sunk and filled with concrete, we re-ran the line by these marks and found that the building had slipped or "floated" toward the new construction about 1½ inches. While there were cracks in the walls, they were not of sufficient size to account for all of the movement and a part of it must have been in the expansion of the building. The behavior of another important building may be of interest. This is a ten-story building with a high tower about 70x30 ft., about 50 ft. east of the southwest corner of the building. The construction is massive and heavy, the outside walls being faced with thick stone. The foundations are the old type of the floating variety. The foundation under the tower was made of rows of rails laid in opposite directions and embedded in concrete.

When the tower foundation was completed it was loaded with pig iron to the amount of the estimated weight of the tower and allowed to stand, the idea of the architect being to take up all the settlement through compression of the soil before the superstructure was built. As the building progressed, this load of pig iron was removed in proportion to the weight of the masonry laid. How well this scheme of the architect worked is shown in our subsequent levels.

We have taken levels on the top of basement piers from the time of construction to the present, at various intervals. At first every week, later every month, and for the past ten years, twice a year. It is now 22 years since we took our first levels and we still find a little settlement. The building as a whole has settled about 18 inches and the tower over two feet. This excessive settlement necessitated the removal of the heating plant to an ad-

joining building, and the raising of the sidewalk above the floor level of the stores. The building shows no cracks and the settlement is not noticeable, except in some irregularity in the floor levels.

With buildings supported on piles, the movement, if any, of the adjoining buildings is quite the reverse from that which takes place when caissons or wells are dug. The displacement of the earth caused by the driving of the piles, which are generally quite numerous and in compact groups, results in a lifting of the surface. I have known buildings of the old type to be lifted several inches and the pavements in street and alley adjoining to be heaved up into small mountain ranges.

In one instance we made a survey of a lot, 100 by 94 ft., in which we gave the elevation above city datum of the walks in front of and adjoining the property, and also the established grade for the outside and inside edges of the walks. The walk in front of the lot was removed. The architect in fixing his first floor, basement and sidewalk levels, used the elevation shown in our plat of survey for the height of one of the adjoining walks, without realizing the effect on this walk from driving several hundred piles in this small area. The building was completed and a new cement walk built.

The Board of Public Works, some time later, notified the owner that this walk was several inches too high and must be lowered to conform to the ordinance. It was three years after our survey was made that the architect notified us of this demand, and claimed it was up to us to pay the cost of lowering this walk and damages to tenants sustained by interference to business during the time required to change this walk. We found on taking levels that the walks and street pavement and buildings had been raised by the driving of the piles, and that our original levels were correct. We were therefore in no wise responsible for the grade of the walk. We never paid the claim and I might add that this walk was never changed.

The city of Chicago has driven several big tunnels for water to supply pumping stations lying quite a distance inland from the lake. The location and driving of these tunnels was kept absolutely secret. Owners never knew of the burrowing under their buildings until they mysteriously began to settle. This caused the surveyors considerable trouble because bench marks made on some of these buildings dropped below the recorded height, and also a number of established concrete bench marks settled. The surveyor would level between two monuments to find they did not agree, both probably having settled, but unequally. It thus became necessary to run a check circuit of levels from benches that seemed reliable, if such could be found, and so determine the true grades. This took much time and added to the cost of making the survey,

and cutting the surveyor's profit, which was inadequate to begin with.

I have recited these various situations to show that the surveyor is constantly coping with situations over which he has no control, and is liable to have claims of errors in his work, made because of them. This causes him anxiety and loss of time, while he is establishing the accuracy of his work. Even if he clears himself of the charges, there is always an impression left in the mind of the owner and architect that there was trouble over the survey, and he becomes to some extent discredited.

The architect, or his superintendent, seldom checks between the marks shown on the survey, to see if angles and distances and elevations are correct, and that he has correctly interpreted his plat of surveys before beginning building. If this was done, it would save much trouble later for all parties concerned. The surveyor is not infallible and is liable to err like any human. He is conscientious and hard working, and doing his best. A spirit of friendly cooperation between surveyor, architect and contractor would, I am sure, be welcomed by the former and save much annoyance.

I have touched on the matter of financial responsibility, which brings up the question of what this should be. Does the surveyor when he issues his plat of survey, assume thereby unlimited financial responsibility and in perpetuity. I do not believe he does. I do not believe that the compensation paid for surveying is for anything more than services rendered. I do not believe that any court would sustain a claim of damages much in excess of the amount paid for the survey. The certificate of survey is not a policy of insurance, guaranteeing the holder harmless from any and all damages arising from an error in survey or difference in surveys betwen surveyors. There is a joint responsibility between the owner, architect, contractor and surveyor and they should be considered as co-insurers.

In one instance we had made a survey of a lot in the loop district. This property and the adjoining was completely covered by buildings. In order to obtain the included angle at the lot corners we were obliged to work on offset through the adjoining streets. The angle read was the supplement of the included angle, but was shown on the plat as the included angle, an error on the part of the draughtsman, and this slipped through the approval of the plat. We received $25 for this survey. The architect figured his steel on this angle and it was all got out and delivered on this basis. We paid $5000 in damages to the owner, for the steel, demurrage and sundry other items of alleged expense. Now if the architect had made any check calculations, he would have discovered that he could not check the dimensions using the angle given. A little cooperation would have saved time and money.

This damage was paid by us without any protest. I had nothing to do with the office management at that time. I am, I fear, more belligerent than my good father was and am sure if this situation should arise now I should protest at the injustice of paying damages of 200 times the amount of our compensation. I know of only one case in which a surveyor has been sued for damages from errors in surveys, and in this case the judge ruled that the compensation did not warrant the payment of damages and none were awarded.

LAND SURVEYING IN MEXICO

BY WILLIAM KRAMER

The right of conquest divested the native of the Aztec empire of all claims to the inherited soil. The conquerors proceeded to divide the territory among themselves and their followers. All land grants were subject to the approval of the Royal Audience and the signature of the king of Spain, and even today the original royal patent must be produced in order to maintain legal title to such lands in Mexico as passed into private ownership before the Declaration of Independence. The lands in northern Mexico, with the exception of a few grants around the towns and trading posts along the great northern highways, were still in possession of the Spanish crown when the republic was formed. Automatically the titles of the land in these vast territories, which at one time included all the southwestern states of the United States, passed into the hands of the independent Mexican government. During the term of Manuel Gonzales (1884-1888) the government saw fit to make an inquiry into all titles of land within the republic's jurisdiction for the purpose of ascertaining the exact extent of the "terrenos baldios" or public lands in Mexico. It was at this time that I had my first experience in land surveying in Mexico.

The real purpose of this investigation was to dispossess certain owners of large tracts of land or haciendas, of their illegal holdings and to establish a cadastral system modeled after the European or Australian institutions. A number of owners were not able to produce the original royal patent with signature of the king of Spain attached, as provided by the congressional act governing the validity of titles to "terrenos baldios." Numerous lawsuits were soon instituted by the government, the object being the legal disposession of the owner and the reclamation of the public domain. This work would have been highly commendable and beneficial to the interest of the country if the authorities had made a systematic and impartial investigation of the tax records and the archives of the districts in the different states and territories. Instead of

creating a permanent organization to perform this work, the government assigned certain states to different contractors, who upon the legal recovery, confirmed by the courts, were given one third of the value of the property recovered, as legal compensation. In turn these contractors employed attorneys to fight the legal battles of the government in the courts, their compensation being half of the proceeds of the contractors.

The surveyor was under the direct orders of the attorney and usually was given a part of the proceeds of both contractors and attorney, and was also furnished with funds by the contractor to carry on the work and to defray other expenses. In nearly all cases the surveyor, after having performed the work, had to sue not only for his share in the proceeds, but also for the recovery of unpaid expenses. The long and tedious court proceedings eliminated all prospective profits.

The work of surveying was carried on under great difficulties, obstacles and delays. The attorney was supposed to furnish an exact description of the property in question and of the tracts of land bordering the same. In nearly every instance the surveyor had to make his own researches in the archives of the state and district where such records were supposed to be kept. In most of the cases these records were not in existence, having been destroyed by mobs during the almost continuous revolutionary state of the country up to the time of the first term of Porfirio Diaz. It was necessary to interview the owners of the surrounding property, who in a number of cases resided either in Pueblo or in the City of Mexico. After having obtained an order from the government of the state to the presiding judge of the particular district in which the tract was located, the surveyor set out on a long and tedious trip by stage or on horseback to the district capital and there presented his credentials to the judge and awaited the pleasure of the court. The courts were never overburdened with work and it would not have caused serious inconvenience to the judge to dispatch the work for which the surveyor applied, but the customary formalities of official etiquette had to be satisfied. The date for the official presentation of the credentials of the governor had to be set before they could be delivered, and the customary social calls had to be made before the court finally took official action.

The court would then issue summons to the owners of the tracts of land which surrounded the property to be surveyed, to present themselves at a certain place or point of beginning, where boundary disputes could be adjusted and whence the court would set out for a trip around the property in order to give all parties concerned a hearing at the particular point of dispute. During the intervening period the surveyor had to put in his time according to his own inclination and amuse himself as best he could. On the appointed day the surveyor accompanied the court to the meet-

ing place, where the clans were already awaiting him. The formalities would take up the best part of the day and during the official reception following, acquaintances were renewed, family affairs gone over, political matters adjusted, and the news of the district communicated.

In one case I have in mind, there were eighteen owners of adjacent tracts, who with their followers and servants made the point of beginning appear as the starting point of a small army rather than a place for court proceedings. They were all on horseback, attired in the customary finery. For the subsistence and entertainment of the party elaborate arrangements had been made by each owner. The gentlemen were owners of tracts of land to the extent of not less than 25,000 acres each and most of them were the direct descendants of "conquistadores." They carried with them the original royal patent of their holdings, signed by the king of Spain and countersigned by the Royal Audience of New Spain. In turn each presented his evidence of legal ownership to the court, which in the open, officially passed upon each title.

The next day the party started on the trip around the boundaries of the hacienda. At each corner a separate protocol was taken, setting forth the history of the monument, its reference in the descriptions of the tracts, and the acquiescence of the abutting owner. At disputed points, the court made its decision on the ground, after having heard the testimony of both sides. In the case of lost landmarks, testimony was taken and the surveyor instructed to erect a new monument according to the direction of the court. In this manner all controversies were amicably settled and adjusted, before the surveyor was allowed to proceed with the work. The proceedings took up three full days, but the time was well spent, as disputes were settled which, according to the testimony presented, dated back in some cases more than 100 years. During the progress of the "diligencia" around the boundary of the tract, the party decreased continually, so that when we arrived at the point of beginning only the court, the notary and the surveyor were left. The notary kept an accurate record of the proceedings, while the surveyor made his notes as to the location, description and reference of the corners.

The Mexican surveyor of these days did his work very much in the manner of the old time surveyor of the frontier states. All tracts of land in Mexico are irregular and polyconic and the only instruments used were the compass and chain. In the case where the court proceedings have been described in this paper, I used the method of triangulation, the topography being of a distinctly mountainous character and offering difficulties in chaining straight lines. My work and that of a Mexican surveyor who had previously made an unofficial survey for the owners, and who had worked by or with the ancient method, differed considerably. It

was with the greatest difficulty that I could convince the contractor that the triangulation method was more accurate and therefore more reliable.

DISCUSSION ON SURVEYING

J. W. DAPPERT: Relative to the shifting of marks, I live in a coal mining town, and under about one-third of the area of the city coal has been removed, causing the shifting of bench marks. At one time, I found a water main on a certain street had broken and showed a shifting of 2½ ft. The earth had settled 2.4 ft. in the course of four years. My son took observations on bench marks on good foundations, and found one upon a brick building was off 2.4 ft. I took the level and ran it over myself, and got the same results. Later on, I had occasion to observe a settlement of 2.07 ft. on another building. Twice the water pipe near by had broken, and was replaced and renewed. The side-walk had been laid on a grade of about 3 to 4% down-hill slope, and that walk finally extended itself 2½ feet beyond its original location. Various sections have settled throughout the coal regions at Witt, Taylorville, Springfield, and other places, and it has caused much litigation.

G. C. HABERMEYER: In the revision of the State Constitution, it would be especially well to have some surveyors called in, and have the laws for which they are working revised at this time, if it is possible. Surveyors are still working along as they were 30 or 40 years ago, and it is especially important now that their compensation be changed and that records of their work be preserved.

E. A. ROSSITER: About six years ago a bill was presented to the legislature and among its various items was: evidence and trespass. Our text books teach us how to make a theoretical survey, and after carefully making such a survey our Supreme Court comes along and tells us we are all wrong, because Sam Jones or Bill Smith has occupied his line over 20 years so that his crooked old fence line is the property line; therefore the surveyor should take evidence under oath. Then the question of trespass arises. You may know that my father was killed in 1905 in Indiana while surveying across a railroad. The case was carried to the Supreme Court and an opinion brought down that he was not a trespasser. The laws of Illinois give no such right or protection to a surveyor.

The next item is one of record. I have records dating back to 1839 and many ante-fire records that are valuable, surveys are made according to these records but when I am gone my clients are at the mercy of new surveyors who did not have the advantage of these old notes and records. All record plots should be of uni-

form size and the originals left in the hands of the recorder. The following suggestion may be of interest:

(A) Any surveyor may take the evidence under oath or affirmation of witnesses whose evidence may be useful in establishing any part of a survey. He may take and attest by his seal acknowledgments of plats, deeds and other documents relative to real estate in the manner provided for notaries public.

(B) Any surveyor, while in the performance of his duty, together with his assistants, shall have the right to enter or cross any lot, tract or parcel of land or right-of-way without being subject to trespass, but subject only to the right of the owner of such land to collect any actual damage caused by such entry.

(C) Any person interfering with the surveyor, his deputy or his assistants in the proper discharge of his duties shall be subject to a fine of not less than $20 or more than $200, and to such additional damage as his interference has caused.

(D) No person, village, or town or city authorities, shall remove or obliterate any section or quarter-section monument, or mark designating a section or fractional-section or a reservation, grant or United States boundary line. If permission to remove or obliterate any such monument or mark is desired application shall be made to the county surveyor who may grant at the expense of the applicant such permission, first making provision for preserving the exact location of the original boundary or mark. The surveyor shall cause a full description and designation of such new witness marks and monuments to be recorded in the office of the county surveyor.

(E) The office of the county surveyor shall be one of record and there shall be recorded and filed in his office, all matter concerning the public roads, highways and bridges of his county, with documents, petitions, surveys and other papers, in order to have the complete history of such records.

(F) The surveyor shall keep in a book an accurate record of all surveys except of city lots made by himself or his deputies for the purpose of locating any lands or road lines, or fixing any corner or monuments by which the same may be determined, whether official or otherwise, which surveys shall include corners, distances, angles, calculations, plats and a description of the monuments set up, with reference thereto as will aid in finding the same. This book shall be kept as a public record by the county surveyor, and also any other surveys made in the county by competent surveyors duly certified by such surveyor to be correct and deemed worthy of preservation, may be recorded by the county surveyor.

THE NEED OF A STATE LAW TO REGULATE HOUSING

BY CHAS. B. BALL*

"The reform of the habitations of the masses of the people must precede all other reforms, and without that all other reforms must fail."—Chas. Dickens.

Our Governor in his message to the legislature on January 8, 1919, made the following specific recommendations respecting the conservation of wealth and homes.

*Chief Sanitary Inspector, Health Department, Chicago.

"One of the fruitful causes of disease and debility is improper and insanitary housing. This is probably the largest single cause contributing to tuberculosis, and an increasing number of counties have thought it necessary to build and maintain sanatoria for tubercular patients. It is not enough that the state care for its dependents. It has a right, and it is its duty, to prevent such dependency wherever possible. Other states long since have enacted laws to prevent the building of houses which would be inimical to the public health."

"The time has come when Illinois should adopt some kind of a housing code. If such a code had been adopted a half century ago, without needless burden to anyone we would today have good housing conditions throughout the State. And so, if looking to the future, we should adopt such a code now, the slums, which are the breeding place of disease and crime, would begin to disappear. Such a code might properly be very lenient toward conditions as they now exist, but by rigidly controlling the future, would inaugurate a better day."

The great war activities involved a necessity for dood housing, These needs, which resulted in the construction by the Federal Government of housing allotment in 50 localities in 20 states, have a tremendous influence for the future of housing by reason of the standards thus set. If war housing was imminent, and all agree that it was, peace housing is now no more less imminent. Lawrence Veiller, the seer of housing leaders in America, at the Fifth National Conference on Housing, in October, 1916, made this statement: "We stand on the threshold of a new era in the housing of the country's workers." This prophecy was made before the United States entered the world war. In less than two years we have seen the organizations in the Department of Labor of a Bureau of Housing, we have read the standards promulgated by the bureau, we have noted the appropriation by Congress of $195,000,000 to be used in building houses for industrial workers based upon these standards. A score of new towns have been completed. This war has resulted in an awakening of many communities to the tremendous need of good housing for both the present and the future.

Even capital cities display bad housing. As I inquire how I may best convince you that the cities of Illinois need housing regulation, my thoughts recur to the series of capital cities, stretching across the continent: Boston, Hartford, Albany, Trenton, Harrisburg, Columbus, Lansing, Indianapolis, Springfield, Madison, St. Paul, Des Moines, Denver, and so to Sacramento and the Coast. Of the 14 capital cities named, I have personally observed notably bad housing conditions in more than half the list, and in my library I have indisputable evidence that like conditions exist in the remaining cities. If the capital cities, famed

for stately buildings, parks and boulevards, are not free from the virus of the slum, we must not expect to find, and will not find industrial cities, river towns, and county seats exempt from the inoculation of bad housing.

The report made by John Ihlder on the housing in our capital city of Springfield, 1914, shows in considerable detail the bad conditions which are bound to prevail in any city where the housing is not regulated by law. It shows that the multiple dwelling has taken root in Springfield and has depreciated residence values in the surrounding neighborhood; that dark rooms and privy vaults still persist; that the people still drink water from wells in streets where water mains exist but where connections are not brought into the houses. It shows that in the business section buildings used for stores are occupied in their upper floors without adequate requirements as to light, sanitation and fire protection.

In a paper presented to the State Conference of Charities and Corrections on October 9, 1919, by Professor James H. Tufts of the University of Chicago, statements are made respecting bad housing of various degrees and types in seven cities. He refers to the swampy land in East St. Louis, divided into a series of pools with natural drainage cut out, and long rows of houses built on the edges of these pools. He shows that in Joliet, while the city has an excellent supply of artesian water, the dwellers in many houses rely largely on surface wells. He describes the filthy, dilapidated shacks which constitute the shanty boat section along the river in Peoria. He describes an old hotel building in Quincy occupied by almost as many families as there were rooms in the building. The conditions published by him certainly justify the passage of adequate state legislation which will prevent their increase and will eliminate such slums where they have already begun to grow.

After thirty years observation of large and small American cities, I affirm that housing evils can be found if searched out in all cities having a population of 5000 or more. The degree to which the slum has taken root varies, but in most cities it is well grounded and requires immediate and thorough measures for eradication. The cities of Illinois cannot afford to do without a law which will prevent the increase of housing evils and which will assure adequate space both without and within every dwelling, provide light and ventilation in every room, give protection from fire dangers, secure suitable sanitary equipment, and maintain every habitation in fit condition for occupancy.

Purpose and Scope of Housing Laws. Let us consider the distinction between building, tenement houses and housing laws.

A building code is a set of laws or regulations dealing with the methods and materials to be employed in the construction of build-

ings. It specifies in detail the restrictions which are imposed to render the walls, floors, ceilings and roof structurally safe; methods of resisting wind effects and vibration; the kind and qualities of materials to be used in the important parts of a structure, etc., it is unusual to find in building laws any plumbing, ventilation, lighting or other sanitary provisions. Hence these laws in general do not prevent or remedy evils of any character except those of structures or safety. It is true that some revisions of building codes since 1910 have embodied limited sanitation requirements adapted from plumbing or housing laws, but these are few and exceptional.

A tenement house law which deals with matters of design, sanitary equipment and maintenance of tenement houses; that is, houses in which more than one family lives and therefore in which each family is affected to a greater or less extent by the conditions under which other families in the same building live. The tenement house law of New York City is the notable example of such a law, and is well adapted to houses in which many families co-exist and have a common use of and interest in the halls, stairways, roof, cellar, etc. It is also applied to a dwelling where three families live. When the number of families is only two, it is often the case that these families live almost entirely isolated, with few points of contact with each other, under conditions which are very like those in a dwelling housing only a single family. For this reason, it has been found desirable to frame laws for houses containing two families with somewhat less stringent provisions than those applicable to the larger tenement houses. The single family house is, of course, much more desirable as a home and should be afforded characteristic treatment. The conviction that housing evils are well nigh universal, whatever the kind of a building in which people live and wherever it is located in cities, towns, villages or open country, had led to the framing of general housing laws. The unventilated room, the dark hall, the lack of proper plumbing, the presence of filthy conditions, etc., should be restrained by law in the interest of the whole community, whether they be found in the congested tenement, the two-family house or the piece-meal shanty. Our conclusion is therfore definite that a housing code must apply to every habitation, but may embody modifications suitable to certain types and classes of dwellings.

By reason of the fact that such laws are not commonly on the statute books, a certain propriety exists in applying them at the first to congested cities and the larger towns in which objectionable conditions affect the largest number of people. For this reason, a housing law for the State of Illinois may well be applied to the 40 cities having a population of 10,000 and upwards.

New York—1867-1901—A tenement house law applicable only to New York city and Buffalo.

New Jersey—1904-1917—A tenement house law, based on the New York law, now applicable to all tenement houses throughout the state. This law has been well administered by a State Commission and has resulted in the removal of 411,773 violations during the period of 13 years since its passage.

Connecticut—1905-17—A tenement house law which applies to new tenements only. The maintenance of tenement houses is dealt with in a separate law, 1911-17.

Wisconsin—1909—A tenement house law which applies only to Milwaukee at present, but may be adopted by other cities.

Indiana—1909, 1913, 1917—A tenement house law which applies to all cities. The law of 1917 is applicable to existing dwellings and provides that no unfit, unsafe or uninhabitable dwelling shall exist within the state. The history of the passage of the law for housing control in this state is an entrancing story of the devotion and tactful energy of one woman, Mrs. Albion Fellows Bacon, of Evansville, who has demonstrated how one person can cause an awakening of an entire state to this reform.

Massachusetts—A permissive housing act for towns, 1912. In effect in 23 towns. A permissive tenement house law for cities, 1913. The city of Revere is the only one which has adopted this act.

Kentucky—1912—A tenement house law which affects only Louisville.

Pennsylvania—1913—A housing law applicable to Philadelphia only. A tenement house law applicable to Pittsburgh and Scranton.

California—1909—A tenement house law superseded in 1917 by three acts respectively controlling tenement houses, hotels and dwellings. The tenement house and hotel laws apply to all parts of the state, and the dwelling house act only to incorporated towns and incorporated cities and counties.

Minnesota—1917—A housing act which applies only to Minneapolis. This law affects all dwellings and contains numerous admirable provisions.

Michigan—1917—A housing code applies to every city and village which has a population of 10,000 or more—29 in all. This law is based on the model housing law of Mr. Veiller and is by far the best single example in the United State, both in its scope and the standards which it sets.

Iowa—The draft of an excellent law has been prepared by a State Commission appointed September 6, 1918.

DESIGN AND CONSTRUCTION OF PAVEMENT SECTIONS

BY H. J. FIXMER

The design of pavement sections remains a fine art rather than a scientific procedure. Progress has been rapid the past few years in developing adequate bases or foundations and suitable wearing surfaces. However, considerable experimenting, scientifically directed, must be had before design can be said to rest on any but an empirical basis. The function of the base and wearing surface, as a structural unit, is to resist the wear and strain imposed by the traffic and to transmit the resultant pressure over an area of subgrade capable of withstanding such loads. In designing a proper pavement structure three factors must be known or at least intelligently assumed: The allowable pressure the subgrade can safely support; the structural strength of the pavement structure proper; and the amount and character of the imposed load.

The first two factors are determined by engineering investi-

gation or experience. The fixing of the third factor, namely, amount and character of the load, is uncertain. This matter of load imposed by the traffic must be established by law. If we are to protect our pavements there is no other way. There is no question but that the public has the legal right to regulate traffic; the determining of these regulations from the economic standpoint, a purely engineering problem by the way, is the great problem before us today. The auto truck furnishes the greatest traffic stresses which we must design our pavements to meet.

The factors to be considered in determining the wear and strain of wheel loads on a pavement are: the maximum load on one wheel, the diameter of the wheel, width of tire, kind of tire (rubber or steel), kind of springs, smoothness of pavement surface and speed of vehicle.

It appears to be the general consensus of opinion that the trucks known commercially as the 5 to 7 ton truck is at this time the maximum size which is economical to operate in general service. This truck weighs from 7 to 7½ tons without load. When loaded with 5 to 7 tons the total maximum weight is about 14 tons. Since the rear axle carries approximately ⅔ of the load, there would be a trifle less than 5 tons on one rear wheel. A maximum load of 5 tons on one wheel should be the established limit. The width of the tire, if rubber is limited by the strength of the rubber structure, which has been experimentally determined to be about 800 lbs. per inch in width.

The necessary width of rubber tires (in inches) is assumed to be equal to the tons on one wheel multiplied by 2.5. Because of the lesser area of contact and effect of greater impact of a steel tire width must be wider than a rubber tire for a given load. The width of steel tire (in inches) is assumed to be equal to the tons on one wheel multiplied by 4. The factors, diameter of wheel, kind of springs and smoothness of pavement surface may be neglected at this time as their effect is small; it being understood that a smooth surface is a part of the design.

The matter of speed is highly important. This must be regulated because of public safety, effect on wearing surface and pavement structure, and effect in determining roadway widths. The allowable speed should be determined by the factors of weight on one wheel, width of vehicle, kind and width of tires and the character of the highways or thoroughfare. Taking the passenger automobile as the basis, the speed should be limited by consideration of public safety to from 10 to 30 miles per hour. The locations where these limits would be imposed would range from a business street to the wide through route or unfrequented country road. The speed of trucks should be reduced below those permitted for passenger autos, depending upon the load carried.

In regulating the speed of trucks the following formula is

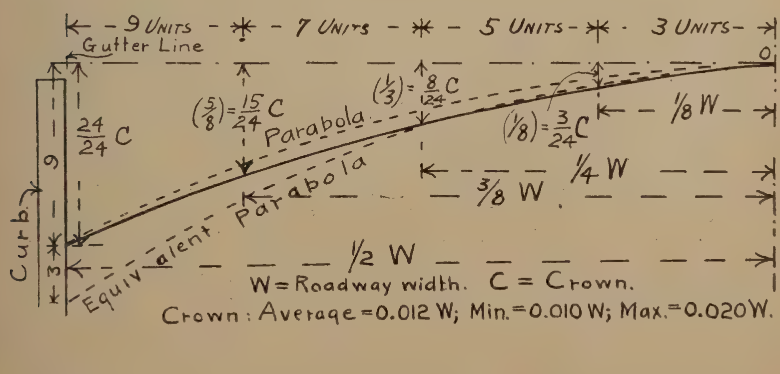
suggested, where S=permissible speed for trucks in miles per hour. P=permissible speed for passenger autos in miles per hour, and W=weight in tons on one wheel. Then $S = [P \times (9 - W)] \div 10$. This formula applies where vehicles are equipped with rubber tires. When steel tired vehicles are used, such as trailers, then, $S = [6P \times (9 - W)] \div 15$. This reduction is advisable because of effect of impact and absence of brakes on such vehicles.

The width of the vehicle limits the speed which may be allowed because of the necessity of providing an increase in clearance for a corresponding increase in speed. For safety, a vehicle 6 ft. in width should be provided with a width of roadway of 10 ft. when attaining a speed of 30 miles or more per hour. For each line of traffic therefore, the width of roadway should be a multiple of ten. This may be modified where parking or standing space is required. Parking width may be assumed at 8 ft. With a 10 ft. width allowed for each line of moving vehicles a vehicle 7 ft. wide should be limited to 20 miles per hour and a vehicle 8 ft. wide to 10 miles per hour. Eight feet should be the established limit. We must not only build and maintain our streets and roads, but protect them and their use by proper regulations effectively enforced.

Were the above limits adopted and enforced the engineer could design a pavement that would accommodate the traffic in an economical, safe and satisfactory manner.

NEW DEVELOPMENTS IN DESIGN

To accommodate present and future traffic which is becoming entirely self propelled, more attention must be given to fitting the surface contour to the new traffic needs. In recent practice in Chicago a new form of crown section has been adopted. As shown in the drawing, instead of the familiar parabola a flatter curve is used. It shows the position of the new crown line with reference to a parabola having the same depth of gutter at the curb and an equivalent parabola passing through the shoulder or quar-



ter point. The advantages of the new crown line may be outlined as follows: The new crown line when increasing the cross drainage near the middle of the roadway permits a reduction of total crown slope of 25 percent. It secures better drainage, a more satisfactory surface, increases the safety to traffic and thus increases the width of ‘‘available’’ roadway, thus distributing traffic which in turn results in increasing the life of the pavement. On very wide roadways, the slope from the quarter points to the gutter may be decreased by substituting a straight slope for the increased curve slope.

Recently the radius of curb corners has been increased. The standard for the typical residence street is a 10 ft. radius at street intersections and a 6-ft. radius at alley returns. For business streets the general standard is 6 ft. for both streets and alley corners. On wider streets and streets having certain kinds of traffic predominating, larger radius corners are being used. This improvement adds to the convenience of traffic, improves the appearance and reduces the danger of accidents and reduces the destruction of curbing at the curb corners. While the area of paving is slightly increased, the amount of curbing is reduced. The difference in increased cost is in my opinion money well spent. The depth of the gutter below the top of the curb has been reduced. On combination curb and gutter this results in a saving in cost, less breakage of curb, a better appearance, and on all streets a saving in amount of excavation.

NEW DEVELOPMENT IN CONSTRUCTION

On one job under my supervision the past year the concrete for the pavement base was mixed at a central plant and hauled by motor trucks to the streets under construction. About 13,500 cu. yds. of 1:3:6 concrete was handled. The base was 6 in. thick and comprised about 80,500 sq. yds. laid on streets 18, 24 and 30 ft. in width. The width of road ways were proportioned according to the traffic need or character of frontage.

The mixing plant was installed alongside a temporary siding off the main line of the C. & N. W. Ry. The plant comprised two temporary switch tracks, on one of which a locomotive crane operated, transferring the sand and gravel from the cars on the adjacent track to two elevated bins of about 50 cu. yds. capacity. In addition to the bins large storage or stock piles were built up to anticipate car shortage. Alongside the bins was a ground level cement storage shed. The mixer was elevated with the discharge chute about 6 ft. above ground, on the side of the bins away from the tracks. In front of the mixer a depressed plank road was built to permit the tracks to back in and receive their load. The cement was elevated onto the charging platform by an elevator which was hoisted and lowered by a rope attached to the drum which

ordinarily operates the charging hopper, which in this case was superseded by the elevated bin.

The sand and gravel was proportioned in an old asphalt measuring box which held 6 cu. ft. of sand and 12 cu. ft. of gravel, which was discharged into the mixer along with two bags of cement. This was the standard batch. The concrete was hauled by motor trucks, four or five being used, depending on the haul, which averaged less than a mile. The time of haul from the mixer to street varied from 10 to 20 minutes. Each truck carried four batches which would lay 12 sq. yds. of base; a fair average day's work would amount to about 1800 sq. yds. When the trucks reached the sub grade they were backed onto the previously-laid concrete a distance of about 4 ft., and then dumped from the end by elevating the truck body. In this way the slush which occasionally separated from the concrete was automatically spread over the previously laid concrete and not wasted. There was practically no leakage and the concrete was an excellent product. The crews at the plant and on the street were about equal, each having as a rule 10 to 12 men. The 7½-ton Mack trucks were used, equipped with bodies designed to carry asphalt mixtures.

A division plate at an angle of 45° was built near the forward end of the body. This facilitated dumping and prevented an excessive separation of the aggregates. The trucks proved highly efficient, and while no cost data can be furnished at this time, the fact that the contractor is planning to employ this method on future work indicates that it has economic advantages.

G. C. Habermeyer: Is it recommended that for a definite increase in weight there should be a definite decrease in speed? It seems to me that where light cars move slowly it would be necessary to have everything move along at the same speed.

H. J. Fixmer: The idea is considering the future design. It was thought that if a certain type of road would permit passenger cars to travel 30 miles an hour, trucks should travel 15 miles an hour. The proper speed must be determined by the two factors of public safety and protection of the pavement.

(Note—See also the discussion of report of Committee on wheel loads and tires)

J. G. Gabelman: Mr. Fixmer is right in one respect, but when you get down to slow speeds, the formula will not work. The minimum limit in my opinion should be 6 miles per hour. When trucks run slower than that, they tie up the highway. I cannot see the connection between a pleasure car and a truck. He has differentiated by the load on the truck. What is the difference between a one-ton truck and an ordinary passenger car? There would be very little difference, so far as doing harm to the pave-

ment is concerned. Between a two or three-ton passenger car and a one-ton truck, the first might do more harm than the other. Then you might put a solid tire on one and a pneumatic tire on another and there would be a difference.

In regard to the crown section and gutter slopes mentioned by Mr. Fixmer I might say that it occurred to me that the public was paying for improvements, and improvements should not only take care of traffic, but be built in such a way as to give most comfort to the public. You have all noticed in cities when riding on pavements, that when you get along the side of the road, there is quite a discomfort. We have tried to get a design that will give as much comfort in riding along the gutter as when riding on the crown of the road.

SUGGESTED METHODS OF FINANCING PAVEMENT MAINTENANCE

BY F. C. LOHMANN

The subject of financing road and pavement maintenance has not received the consideration from engineers to which it is entitled, compared with the attention given new construction; but I believe that as the mileage of roads and pavements increases and renewals become more necessary, maintenance will become as important an item as it is in railway work, where in reality it is the predominant feature. It is comparatively easy to secure funds for new construction under our present laws in this State, but it is not easy to secure funds for maintenance and it seems to be a foolish policy to go along year after year increasing the mileage of pavements without proper provision for their maintenance.

At present in city work we are depending on only two sources of income: 1, appropriation from general taxes; 2, (in some few communities, not all) the revenue from a vehicle license ordinance. Not until some other and more adequate methods of financing are obtained will it be possible to see the results in maintenance that are not only desirable but necessary.

Most of us are familiar with the results obtained under the first method; that is appropriation from general taxes. In fact nothing has been done. All of our cities have miles of pavement in poor condition due to this method of financing maintenance. This, I think is because in municipal affairs there is never enough money to go around, and maintenance work suffers the most because it makes the least appeal to the general public. Dirty streets, mud holes, etc., are more apparent to the average observer, who does not realize that neglect may spell ruin for paved streets and hence

does not appreciate the real work of maintenance. As to the second method of obtaining money, this has not become very general because of the objections of the public to a multiplicity of taxes. But where it is in vogue, better results have been obtained.

In order to carry on maintenance work, trained men are necessary to get good results. To have trained men they must be employed at this kind of work continuously. In addition the men must be employed throughout the full working season so as to keep them satisfied and prevent the necessity for frequent reorganization of the maintenance gangs. This means that in any city there is a minimum maintenance gang which should be organized and employed continuously on maintenance work only throughout the entire working season, if proper maintenance work is to be secured. To accomplish this it is absolutely essential that adequate funds be available to properly equip and keep employed at least this minimum gang.

The city of Champaign has carried on its maintenance work in this manner for the past three years. We have been operating a minimum gang consisting of a foreman, three men and one-horse wagon and driver. To operate this gang throughout the nine months suitable for this work it has cost the city during the past year $6039. Of this amount $3800 was for labor and $2200 for material and equipment. We have found that this gang is not large enough, and that sufficient funds cannot be obtained by present methods to properly maintain our 35 miles of paved streets.

It is argued by some that all maintenance cost should be paid by the user of the street. I believe that traffic should bear some portion of the cost, but I also believe that an analysis of the causes for maintenance work would substantiate the statement that the general public, the property owner or both should bear a large proportion of the cost. Maintenance work may be divided into three classes: 1. That made necessary by faulty construction, the cost of which might properly be charged to the general public or the abutting property. 2. That made necessary by the action of the elements, which might also be charged to the property or the public. 3. That made necessary by the action of the traffic and which obviously is chargeable to the user of the street.

The proportion that each should bear is hard to determine, and therefore it is difficult to arrive at a just and proper method of securing funds. Assuming that traffic can be made to pay its just share by the operation of a vehicle license ordinance there appear to be three available ways of obtaining the additional funds necessary, each of which requires some new legislation in addition to our present laws: 1. By increasing the amount allowed to be levied for general municipal funds. 2. By amending the local improvement act so that a fund may be provided when the assessment is spread. 3. By levying a special tax for maintenance work

separate from our general taxes and in addition to the amount now allowed by law to be levied.

Whatever the method adopted of increasing funds for maintenance I believe it should insure that the money will be used for one purpose only; that the amount of money available will be sufficient to cover the full needs of the community, and that it will be elastic enough to cover future expansion of cities along this line. The method of determining the needs of the community must be based upon scientific principles; that is, upon the yardage and kind of paved streets.

The first method stated above (that of increasing the general taxes) would fail to comply with any of these requirements in that the money could not be set aside by law for special purposes, so that conditions existing at present would still prevail. Therefore, sufficient funds would not be set apart to serve the needs of maintenance and consequently scientific methods could not be employed to determine the amount and distribution of money required. The second method (the amending of the local improvement act) would fulfill all conditions. It would be elastic and specific, and scientific principles could be employed, but it would have the disadvantage of conflicting with the idea that most people have, that when a pavement is once constructed the public should care for it. It would also increase the cost of the improvement to such an extent as to retard much needed developments.

The third method (a special or additional tax) would fulfill all conditions and have none of the objections of the first two methods and in addition it would be the easiest to obtain from the legislature. From what I can learn the legislature is more apt to provide funds in this manner than any other, because the need is usually apparent and the amount not excessive. Hence, I believe that this method is the most desirable and that the engineers of the State should take some concerted action to secure legislation along this line.

MR. WINDES: I believe that the maintenance cost should be spread with the original assessment in connection with the improvement; that is, the raising of maintenance money should be done under the local improvement act.

MR. LOHMANN: The raising of money by special assessment for maintenance work would limit its use to the particular work for which it was assessed. If the maintenance required was greater than the amount assessed, which might frequently occur on our heavy-traffic streets, due in part to change in character of traffic, we could not use money that might be avaiable because the money has been assessed for certain improvements only and as a result our maintenance would suffer. We need a fund that can be spent for this work without such restrictions.

WATER PROBLEM IN CONCRETE PAVING

BY B. H. PIEPMEIER

One of the important points in figuring on a concrete job is the water supply. We get the maps of the surrounding country and see what we can find in the way of streams, wells, ponds, or lakes. Many jobs have been more or less hampered because of the lack of adequate water supply. The best supply is that from the river or stream, but the distance of the supply from the work, of course makes quite a little difference. We usually try to get a water supply as near as possible, three or four miles being the greatest distance we have pumped. We use, as a rule, a 2-in. pipeline and gasoline pumps. We equip the pipe line with 200 T's 300 ft. apart, and then use 150 ft. of 1¼ in. hose from the pipe line to the mixer. This perhaps is the usual custom now followed by contractors for their supply of water to the mixer. We put a relief valve at the pump and then arrange to have the pump man stationed where the pump is installed. So far, we have had very little trouble with our water supply.

A few kinks in our supply of water might be of help to contractors and engineers. One is that when you have construction that will extend late in the season, it is an advantage to plow a furrow and lay the pipe line in the furrow, after which it is covered by plowing two furrows over it. This keeps the pipe from freezing, and it does not take very much of a freeze to tie up the work all day. Covering the pipe is better than attempting to drain it at the low points. As to trouble with split pipe, I have found it an advantage to have a few pipe clamps on the job. They will prevent serious leakage for a long time. On account of the pipe line bursting in places, it is frequently necessary to install a new section of pipe. A piece of hose installed at intervals of about 1000 ft. makes the pipes more flexible. You can shift a 1000-ft. or 500-ft. length either way, and insert a new section of pipe line quickly and that is a decided advantage.

Concrete is freely used on road or pavement work, whether it is brick or concrete, and therefore considerable water is required for mixing and curing. On two jobs last year, all the mixer could run was three hours, and then the gang was tied up and had to wait until the well filled with water, this proved to be very expensive. They had a reservoir which they thought was sufficient, but when they came to using the mixer continuously they ran short. We have used wells in our construction work, but I think that the creek or river is much more reliable. There are some locations in Illinois where the well cannot be pumped dry, and under such conditions wells furnish a very desirable supply. You can put in an ordinary lift pump of 150-ft. lift with a small gasoline engine and pump the water into a storage tank; then use your force pump to supply water to the main line going out to the mixer.

Many contractors install two small pumps. This is an advantage and the additional cost can usually be justified. Nothing less than a 2-in. suction and 2-in. discharge should be installed for road construction. I am inclined toward the triplex pump, directly connected, for furnishing the water.

The water problem is a very serious one in country road construction. A lot of contractors have lost money on account of not properly providing for their water supply. I am not familiar with the exact quantities required for a day's work, but we usually figure about 15 gallons of water to the square yard of concrete pavement. I should say between 7 and 8 gallons per square yard is theoretically needed for the mixing of the concrete. You will need an equal amount for curing. That makes about 15 gallons per square yard. If you use the three or four sack mixer, mixing 500 to 800 square yards per day, you can get some idea of the quantity of water that is needed, besides the water needed for curing the concrete. There is usually one man on the job using a hose or using water in the pond system of curing. He will use just as much in the curing of the concrete per day as you will use in the actual mixing of the concrete, so if you are going to use 15 gallons to the square yard for mixing and curing, you may need possibly 15,000 gallons per day.

We find that we can get strength in concrete faster by limiting the water than perhaps by any other way. At a meeting of our district engineers we were unanimous that concrete hereafter had to be very much dryer for road construction. We believe that this is one way of increasing the strength of concrete economically.

DISCUSSION

G. C. HABERMEYER: In certain portions of the State, the southern part for instance, a person might get water that is quite highly mineralized, but I suppose in any case there would be such a small amount of mineral in the water that it would not seriously affect the concrete. It would be well if the State would provide a laboratory for determining such matters. As to the quantity of water available for the work, very often it is not a good deal. At present our records in the State Water Survey refer to supplies sufficient for small cities, but for some localities there may be information on file to show that there is enough water to supply a road construction camp. We try to give the contractor information as to location of water, but it is not thorough enough to be reliable.

F. H. NEWELL: We should consider the quality as well as the quantity of water and contractors on roads have had trouble from neglect to give attention to both these matters. We appreciate that water is one of the most essential minerals in mixing and curing concrete on road work yet we have not given enough

thought to its freedom from injurious substances. As I understand from Mr. Abram's experiments a very small quantity of organic matter, such as occurs in swamp water, may have a deleterious effect upon concrete. The engineers for the State or city or whoever is putting up the money should see that tests are made of the water used.

MR. SNEEDMEYER: Many contractors have suffered financial loss from not knowing the conditions as to the local water supply. In the road work about to be let by the State we shall have contractors who are not familiar with conditions throughout Illinois and this uncertainty may run up the prices. Some authority ought to be able to give these men definite information and so save the State thousands of dollars.

B. H. PIEPMEIER: One drawback to this is that different contractors have different ideas as to water. Some will not use a deep well, they would rather go three or four miles to a stream as they are accustomed to using water from streams. We might make a complete water survey and make recommendations, but I doubt its value. The point is well put, however, and is worthy of investigation. The Lincoln Highway contemplated for early construction has few places where we could depend on streams for water, and therefore must depend on wells. These wells could be tested and a report given out for contractors' information which would be of considerable value.

C. C. BROWN: If you have a supply of water that is sufficient for a maximum demand, then there is no question except the size of the pump and pipe on the job. When the supply of water is doubtful then it is a question which is up to the contractor to determine what he wants to do. He should know the maximum demand when mixing concrete, and the total quantity he needs to use within working hours. If his water supply is small he will not be able to supply the maximum quantity of water without some means of increasing the supply. The question will come as to whether he shall use a small supply with storage, or go a greater distance and have a supply which is sufficient for the maximum demand. That is a question for which the contractor and the Highway Division should be responsible.

F. W. DEWOLF: It might be an advantage to consider the cooperation of the State Water Survey in connection with these road plans. Unless the Highway Department, in its surveys of road locations can take the time to get data on water for the information of the bidder, it might be desirable if the Water Survey were supplied with suitable equipment, one or two men and an automobile, so that reconnoisance studies of the water supply along the route of such roads may be made in advance and furnished to the contractor. That is the sort of thing that is contemplated in the civil administrative code where it states that certain

of these agencies shall cooperate so far as it is desirable with this Department, having administrative powers in regard to these several lines of work.

A. N. TALBOT: With reference to the quality of the water, I judge that there are not many places where the quality of water would affect the concrete very much. With reference to the matter of curing, one matter is not generally understood. It is important to keep the concrete wet for as long a time as possible, in order to secure early strength at the surface, and it is known that concrete which has not been wet but which is allowed to remain in the air subject to air conditions of dryness, will not gain any strength beyond what it had at first. Concrete which is kept moist will have a gain in strength for a considerable period. It is not generally known, however, that if after several years the concrete is given proper water conditions, there will be a further curing and hardening, and a considerable addition of strength. That is applicable to our pavements where they may be kept damp, in low places, or where water falls. Damp conditions of spring and winter may be advantageous to the concrete in that it will provide sufficient moisture and that hardening will continue for years. I have seen cases of concrete roads that when built I thought could not last, but because they were kept moist, gained considerable strength.

B. H. PIEPMEIER: Some contractors have used the pond system of curing concrete, where the grades will permit. Dikes may be built along the side and across the road and the surface then flooded, the small dikes holding the water on the pavement until the concrete is properly cured.

MR. THOMAS: Last year, a contractor started out on a very hilly country, to cover the pavement with dirt and then kept this moist by frequent sprinkling. I persuaded him to stop and use the pond method. As a result, we got better work, and it was much cheaper. The trouble that I have found was that they get the dirt on the concrete but forget to keep it wet. The dirt has a tendency to absorb the water out of the concrete and if more water is not put on it is a detriment. There is a contractor who has a new method of curing concrete. His argument is to insulate the surface of the concrete pavement with bituminous material, the idea being to hold the water in rather than trying to put it on afterwards. With this plan he claims to keep the water from evaporating.

A. N. TALBOT: If evaporation is really prevented, there will be sufficient moisture in the concrete to continue the hydration for a considerable time. That has been shown. However, it did not continue more than a year or two, after a considerable time the water was used up, so that it would be an advantage probably for a few months, and beyond that of course, it may not be needed.

RECOMMENDED STANDARD PRACTICE IN BRICK ROAD CONSTRUCTION

BY G. H. REITER

The belief is held by many engineers and practical highway builders that brick roads have been too restricted as regard to types. In Illinois, for instance, there evidently can be no one type of brick road that is adapted to the various soil, traffic and climatic conditions that exist from Chicago to Cairo, and from Danville to Quincy, yet, at the present time, our State Highway Department allows but one type of construction. This condition does not exist in other states where an attempt is made to determine the specifications for a brick highway upon the requirements of traffic, the condition of soil and the accessibility of material.

The writer wishes to emphasize that considerable expense and care are warranted in proper drainage and preparation of the subgrade. Without such care no hard road nor any wearing surface can give entire satisfaction. But when this matter is properly attended to, the design of a suitable pavement to be placed upon the subgrade is simplified, for the problem then becomes one primarily of providing a suitable wearing surface and a sufficient thickness of pavement to distribute the wheel loads over a proper area of the subgrade. With a dry subgrade the necessary distribution is considerably reduced.

Motor traffic has revised our road building ideas, and the rapid increase in the number and weight of vehicular loads and the speeds with which they traverse the highways today make other changes advisable. The first attempt of highway builders to meet these severe conditions has been to increase the thickness of the concrete base or the monolithic pavement to provide a corresponding increase in the slab strength. As a matter of fact, a considerable increase in the thickness of the concrete base of any pavement, or in the total thickness of a monolithic pavement, will increase the slab strength but little because of the low tensile strength of concrete, and hence this plan does not promise to be an economic success.

As a matter of fact, is great slab strength what we should be seeking to meet the new conditions of traffic? Is it not impossible for any highway designer to determine how much slab strength is required? Is not the sole value of slab strength that it increases the width of distribution of wheel loads over the subgrade? Where the subgrade is well drained because of its natural character, or because of proper artificial provisions, it secures a uniform or nearly uniform bearing for the pavement, and slab strength is unnecessary. On the other hand, where the condition of the subgrade prevents uniform bearing the slab strength cannot usually be made sufficient to span the depression, and cracking results.

In fact, such distribution of wheel loads may be accomplished as readily with a properly prepared base of waterbound macadam, gravel, bituminous macadam or lean concrete, though in some instances a greater thickness will be required. Such a base covered with brick, having a bituminous or sand filler, might be called a flexible pavement in contrast to a rigid type. It has the advantage of being easily repaired, easily constructed, reasonable in first cost, and will adjust itself to slight settlements or heaving in the subgrade without rupture.

In the 1918 "Proceedings" for 1918 is a paper on "Bituminous Foundations for Paving," by Mr. L. Kirschbraun, who listed as one of the advantages that "Deterioration resulting from the effect of traffic shocks will be considerably diminished on account of the shock-absorbing nature of the foundation; by the transference of shocks to the base and by the absorption of shocks in the base." It would seem that this advantage applies to a greater or less extent to the other bases suggested herein and is of great importance under the probable traffic to which our highways will be subjected in the future.

Local materials have received very little consideration heretofore in specifications for brick highways in Illinois—foreign materials being specified regardless of their accessibility or subsequent cost. This has undoubtedly been largely due to the one accepted type of brick road construction. With the flexible type of pavement, however, local materials may often be used with better results than the more expensive imported materials. As an example,—that material known as novaculite—found in extreme southern Illinois, would make an excellent base for any type of pavement where slab strength is not considered of primary importance.

At the 1918 meeting the writer discussed some of the facts mentioned herein, and also spoke of the vertical fiber brick which has attained such success as a paving material in that territory west of the Mississippi river. During the war the government urged paving brick manufacturers to standardize their product as a matter of economy. The need for such standardization can be seen from the fact that one paving brick plant had in its yard 42 different kinds of brick. This adds to the cost of brick to the user, and an attempt is being made to correct this condition. For that reason the National Paving Brick Manufacturers Association, which embraces practically every paving brick plant in the country, has adopted as a standard paver a brick 3x4x8½ in., which lay 38 to the square yard with the 3 in. dimension as a depth, and 48 to the square yard with the 4 in. dimension as a depth. For the present other sizes may be obtained, but economy will urge the use of the standard size.

In presenting for consideration a flexible brick pavement, the

ease of repair and maintenance should be kept in mind. The necessity for such maintenance will increase, of course, in proportion to traffic. There is a pavement around the public square at Mt. Vernon, Ill., which was laid on a loose stone base with a sand filler between the brick. After 20 years of wear the brick were turned over and the other side subjected to traffic. Similar instances may be noted. This certainly should have a bearing on the type of brick pavement selected.

The oldest brick pavements have been laid on the natural soil or a broken stone foundation and the joints between the brick have been filled with sand. Insufficient care was given to the preparation of the stone base for many of these pavements, and improvement has since been made in the manufacture of paving brick, yet these old pavements are in good condition where they have not been subjected to careless removal and replacement in order to repair service mains under the pavement or for other reasons. In suggesting what may be a new principle to many, the writer does not wish to be understood as recommending that any other good type of brick highway be abandoned. He does wish to urge, however, that considerations besides that of slab strength be made for best results, and that the item of first cost be not wholly disregarded when equally satisfactory results may be obtained with a pavement designed on a somewhat different principle.

DISCUSSION ON ROADS

H. C. Adams: The gist of Mr. Reiter's paper was to ask engineers not to abandon some of these old standard types of brick pavement. I do not think you could construe his paper as abandoning the monolithic type. Speaking of the disposition of the State Highway Commission to adopt one standard type of brick pavement, the monolithic pavement, I should like to say, has one feature that has attracted some attention. Concrete is composed of cement, sand and coarse aggregate, the monolithic brick pavement is also composed of cement, sand and coarse aggregate, but the coarse aggregate is very coarse—it is a paving brick. We wonder if engineers generally do not overlook one thing in designing a monolithic brick pavement—and that is, the so-called beam strength, or road distribution strength. When engineers design a concrete pavement they have in mind that it must have so much value as a beam. When they are designing a monolithic brick pavement we will assume that they have the same thing in mind, but it seems to me that when they design a monolithic pavement for some reason or other they make the brick beam thicker than the concrete beam, while the reverse ought to be the case. It has been tested and proved in a great many instances in laboratories that a slab with a brick in it, like the monolithic type, is much stronger in beam strength than the ordinary concrete slab. Engineers

should at least make it the same thickness, if beam strength is the thing that determines how thick the slab should be. If the monolithic slab were made thinner a good deal of material would be saved in construction—and that is just the point. It has been proved at the University of Illinois that a slab with a brick in it can be made thinner than the concrete slab and yet furnish the same load distributing strength.

G. H. REITER: May I add that without having any definite figures I assume that 95% of the brick pavements in this country are of a flexible, or semi-flexible type of construction. I understand that the traffic to which some roads in Ohio are subjected by motor-driven truck trains of the Government, going from mid-west points to the Atlantic coast, showed some very remarkable results. For instance, the point brought out in Mr. Kirschbraun's paper last year, that bituminous pavements absorb the shock of traffic transmitted to it, was illustrated in the fact that brick pavements, with sand filler and macadam base withstood the continuous traffic of these motor truck trains better than monolithic brick pavements subjected to the same traffic.

C. W. COLLINS: In 1918 a brick road with a mastic filler and a rolled stone base was completed 14 miles in length and 18 ft. wide on the National road west of Zanesville, Ohio. Immediately upon completion it was subjected to a very intense traffic of army auto trucks going to the Atlantic coast. It made an excellent record for this type of construction in the way it stood up under this traffic. The advantages of the brick pavement with a bituminous filler and a bituminous bound or rolled stone base may be summed up as follows: 1. No time is required for cutting or seasoning, for upon completion it can be opened immediately to traffic. 2. Openings for access to underground service mains can be made with great ease and a minimum of cost. 3. Every joint is an expansion joint, preventing blow-outs and objectionable noise due to brick surface rising from the foundation. 4. It is a pavement with a resilient, elastic base, and a tough, wear-resisting surface, making a combination unequaled for modern vehicular traffic when built on a properly prepared and drained subgrade. 5. It is the only type of brick pavement unaffected by change in temperature and therefore that does not deteriorate when subjected only to the elements.

H. J. FIXMER: I think the stand of the Highway Commission is correct in view of the character of the traffic we are providing for. For old-style traffic with iron tires pulled by a horse, there is no question that the elastic pavement is more comfortable to ride upon. Where most of the traffic is equipped with resilient tires and springs a rigid surface is best and in the end will prove to be more durable. The Highway Department's position in the matter is absolutely sound.

B. H. PIEPMEIER: Our district engineers are unanimously in favor of a monolithic brick pavement. In the past there has been opportunity for constructing bituminous, macadam, or gravel foundations with the brick wearing surface, but with heavy traffic ahead of us it seems to me that we are compelled to construct a more rigid type of pavement. We admit that ten years from now we will have as many trucks in Illinois as we now have in the United States, and the question comes up in the minds of engineers as to what type of pavement is going to withstand the heavy truck traffic. I question whether any of us know, we can only make a prediction. We lack information as to what heavy traffic will do to the various types of roads. The Division of Highways has contemplated the building of experimental sections of road, with different types and by different methods, and subjecting them to excessive traffic so as to find out just what would happen. This would give us some information as to what loads would do on the various types of pavements. It would not, however, give us the information as to what the elements would do on a pavement. That is an important point also. We all realize that a pavement that has no traffic at all will crack and deteriorate to some extent. We have been more than satisfied with the monolithic brick road construction, and brick people have to prove to us that the resilient type is better. We are not fixed in our ideas except from our experience and experience seems to indicate that it is hard to beat monolithic brick. You cannot disregard the beam strength in a pavement, though I will admit that there are instances where it would seem to show that beam strength is not the controlling factor in the design. I am convinced that beam strength must be considered in the design of a rigid or any modern type of pavement. The tests made at the University have been taken into consideration, and the State specifications for brick pavements have been designed accordingly. We attempt, and have always attempted, to design both concrete and brick pavement so that they would be equal in strength.

MR. WOOLLEY: With reference to that test road system, a concern making particularly heavy tires for trucks proposes four miles of test roads to determine the effect of truck travel on different types of roads.

A. N. TALBOT: Reference has been made to the methods of designing the thickness of roads and to analyses of the loads and resisting moments for these different roads. For my part, having looked through several of these proposed analyses, I don't feel that we can expect much from such analyses and calculations. The trouble is they have to be based on too many assumptions. Some of the methods are unsound. It would seem, however, that experimental roads built up with different types of construction and with different dimensions and subjected to the same traffic

and the same conditions of weather and soil may be expected to give information upon which we can rely. With reference to limits for wheel loads, it is probable that a 5-ton wheel load is as small as the limit can now be made and this may well be accepted; and yet for myself, I very much fear that if trucks of this kind become as numerous upon the roads that are to be built by the State as may be expected, it will not be very long before some of these roads will be in bad condition, especially where the truck traffic will be very heavy. This prospect should stimulate us to secure the best quality of construction possible.

E. A. ROSSITER: I have heard of several suggestions relative to placing tile under the outside edge of the 18-ft. pavement thus eliminating the puddling caused by constant jar of heavy trucks, or the placing of a single tile along the center of the road with outlets to each side and have suggested to the manufacturer the making of a heavier roadway tile for this use. The failure of most of the roads in the east where army trucks knocked out great spaces of road, was due to improper or entire lack of drainage. Where there was a reasonable amount of drainage this condition was not found and the roads stood the wear of the trucks. Where drainage was omitted the roads were practically ruined.

J. A. REEVES: Probably a special quality of material would be required for drains for such service but manufacturers would undertake to furnish any particular kind or grade of material that engineers may require.

REPORT OF COMMITTEE ON WHEEL LOADS AND TIRES

The committee held a joint meeting with a committee appointed for similar purpose from the Illinois Highway Improvement Association. After discussion of reports of committees appointed by different organizations, and after members had expressed their personal ideas, the committee decided to follow with some modifications the conclusions reached by conference of the state highway officials of the Mississippi Valley Association of State Highway Departments. It therefore, presents the following recommendations for a bill to be presented to the State legislature.

For all vehicles travelling public highways the maximum wheel load to be five tons, with a further limitation of not more than 800 pounds per inch of tire in contact with the road surface.

The over-all width of vehicles on country roads to be not more than 8 ft. (loads of loose farm products excepted).

On country roads for 3-ton vehicles and under, with pneumatic tires, the speed limit of this state as it now exists (25 miles per hour).

For 3-ton to 6-ton vehicles, gross weight, 20 miles per hour with pneumatic tires, and 15 miles per hour with solid rubber tires.

For 6-ton gross weight up to 12 tons, 16 miles per hour with

pneumatic tires, and 12 miles per hour with solid rubber tires.

For 12 tons up to the maximum herein permitted, 9 miles per hour.

The speed limits in suburban districts for each of these different classes to be 75 per cent of the speed limits on country roads, and for thickly built up districts 50 per cent of the speed limit on country roads, provided that no speed limit below six miles per hour be required.

For all vehicles, regardless of size or weights, with steel tires, a maximum speed limit of six miles per hour to be required.

Tractors may be operated that have V-shaped or diagonal cleats arranged in such a manner that two or more cleats are constantly in contact with the road surface, and provided that the load per inch of width of such cleats in contact with the road surface, and when measured in the direction of the axle of the vehicle, does not exceed 800 pounds, provided that no such cleats are more than 1½ in. in depth.

The State Department of Public Works and Buildings to be vested with authority to further limit weights and speed on any road where character and condition of the road warrants such limitation. Municipal or highway officials to have authority to issue special permits under suitable regulations for any load in excess of those herein specified. Skid chains not to be permitted except on vehicles equipped with pneumatic tires. Penalties to be provided for violations of the provisions herein. Municipalities may increase, but not decrease weights and speeds on streets not paid for by state funds.—JULIUS G. GABELMAN (chairman), C. D. HILL, B. H. PIEPMEIER.

DISCUSSION

F. H. NEWELL: What is the legal status of the state or county or city to regulate the kind and weight of vehicles to use the streets? I have seen a discussion in regard to streets destroyed because certain contractors moved heavy trucks over them. The general attitude seemed to be that anybody could run a truck or tractor and destroy the pavements and that the public had no redress.

C. D. HILL: I am pleased to answer that the State of Illinois has control over all the roads in the State. There is a question as to city officials; that power may not have been delegated to cities.

H. J. FIXMER: The committee's report has limited 12-ton trucks to 9 miles an hour. That is all right for city pavements where public safety is the controlling consideration. But what about the highways on which the motor trucks compete with trains or where the road is built adequately for this purpose. I see no reason why we should limit these trucks to a certain low speed because some poor pavement may be damaged. We may have a road

with few turns or crossings and built to accommodate this higher speed. We ought not to try to arrest the development of this kind of truck traffic. Another point is in regard to allowing varying speeds for varying widths of trucks. Speed regulation depends on weight and width of vehicle, width of existing pavement and public safety. Certain trucks should be permitted to exceed say 20 miles per hour. It seems to me we should remove the restrictions, if possible, on truck development. New pavement should be designed to meet modern traffic needs.

J. G. GABELMAN: We simply fix the maximum speed, above which we would not allow trucks to run. If you let 7½-ton trucks run at 20 miles per hour, soon you would have no pavements in the State. If a city has streets that would permit heavier loads, we would allow them to raise the speed.

MR. FIXMER: We should let the State Department of Public Works have the right to restrict the rates of speed on any road if it were proved that the trucks were abusing the road. In this way we could protect our existing roads. It would be well to allow greater speed on roads to be designed in the future, provided we design our roads to meet the greater speed.

D. O. THOMAS: Has there been any comparison with regulatory bills in other States relative to the different speeds for different loads? It would seem that a motor policeman would have to carry a book of tables with him to find out whether a person is breaking the law or not, under this system.

J. G. GABELMAN: Other States and different cities have similar laws and they seem to work satisfactorily. The only place I can see where there might be difficulties in thickly settled suburban districts. Our speed limit may be a little high, but if the roadways are not too narrow there should be no trouble.

MR. SCHNIEDWIND: In certain districts of the east, where they have hard surface roads, and where the cities or towns adjacent to the farming community have motor apparatus, they have made some arrangements whereby a farmer or a man living in the outskirts, can, by paying a nominal tax in the city, secure fire protection, and it just occurred to me would this bill have any disadvantage in this matter. They travel at a speed of 25 to 35 miles per hour, and their weight is not in excess of the weight allowed by us.

MR. PIEPMEIER: We took traffic counts on several roads adjacent to cities of about 2000 population. One showed that in 12 hours between 700 and 800 vehicles passed, of which 65% were motor-driven; 500 motor vehicles per day is about the average, and that will undoubtedly be increased, though I think 500 is a conservative figure. On Milwaukee Ave., Cook County, the av-

erage runs from 7000 to 8000 per day, and at Camp Grant, near Rockford, Illinois, there were 12,000 per day during the busy season.

Mr. Powell: As to the estimate of 500 vehicles per day, on some of the heavier traffic roads in Illinois the Division of Highways has traffic counts very much in excess of that figure. On Milwaukee Ave. in Cook County two years ago the census showed over 7500 vehicles in 24 hours. It has been the experience in eastern states where the truck traffic has developed due to their improved roads that 500 vehicles per day is small traffic. When we get our State system of roads built, traffic will increase more than we can now imagine. We have got to build that system for a large motor truck traffic. Look up the large increase in motor vehicles registered in this state for the past five or six years and you can get some idea of the amount of traffic we may reasonably expect as soon as we get some permanent roads to use this rolling stock on.

THE $60,000,000 BOND ISSUE FOR ILLINOIS ROADS

BY CLIFFORD OLDER

The interest manifested in the proposed $60,000,000 bond issue for a State wide system of roads in Illinois, previous to the November election in 1918, was not confined exclusively to the citizens of this State. The many inquiries received before and after the election indicated that many States were watching the campaign being waged on this question and the final results of the election. The result of the election was most gratifying. The question carried by a vote of 3½ to 1; hence, an era in road construction in Illinois was begun. After an announcement of the vote, the interest of other States began to decrease as it then became a local matter with them and they had their own problems to work out. In Illinois it was different, for the interest began to increase by leaps and bounds but along different lines from anything heretofore experienced.

The two most important questions in which the citizens are taking an active interest at this time are: 1, the location of the different routes; 2, which routes shall be built first. You can readily see wherein either of the above questions afford ample opportunity for a decided difference of opinion among the people residing along the many different routes. Delegations are coming to Springfield daily, varying in size from one to 250, for the purpose of bringing before the Department of Public Works and Buildings

the importance and advantages to be gained by locating the route over some particular road or through some town in which they are particularly interested. Oftentimes, delegations from the same locality, interested in the location of the same route, widely differ on the locations of the road between the various points mentioned in the act.

It is evident that there will not be sufficient money available from the $60,000,000 bond issue to build all of the roads requested by these delegations and this fact they soon recognize and realize the importance of the many things that must be taken into consideration before definitely fixing the location of the proposed routes. The purpose of these delegations is not confined exclusively to the location of a route. They are interested in which road is to be built first and oftimes come for the purpose of bringing to the attention of the Department the many advantages and reasons why the route in which they are particularly interested should be built first.

What is now the bond issue law was very carefully considered by the Division of Highways and afterwards submitted to some of the best legal talent in this State for the purpose of avoiding any possibility of question as to the legality of the bill, and we have every reason to believe that the law conforms to the constitution of the State. However, in accordance with the long established custom, the bond buyers have indicated that from the investor's point of view, it would be well to have the law tried out in the courts before any great amount of bonds are offered for sale. We are expecting that a decision will be rendered by the Supreme Court not later than June, and have no great fear but that the decision will be favorable. There are a great many important things to be considered before actual construction is begun. Therefore, we will take advantage of the opportunity and work out as many of these problems as possible before the decision is handed.

Funds Now Available.—The questions are frequently asked: What is being done with the motor vehicle license fees that are constantly being paid into the State road fund? What is the proper plan for using this fund? We have available at this time a sufficient amount of money for road construction outside of the $60,000,000 bond issue to keep us busy for some little time as you will note from the following:

In 1917 the Legislature appropriated from the Road and Bridge Fund for the construction of State-aid roads a sum which, together with the unexpended balance of previous allotments, amounted to $937,000. These funds have been allotted to the va-

rious counties in accordance with the provisions of the Road and Bridge Act and have been met by a like amount appropriated by the counties, therefore making available for State-aid road construction $1,874,000. In addition to the State-aid funds available, the Federal Government, beginning in 1916 by what is known as the Postal Federal Aid Act, allotted to Illinois approximately $2,000,000 for the year 1916, increasing the amount each year until July 1, 1920. At the present time there is approximately $2,647,000 of Federal-aid funds available for immediate expenditure. Summing up the situation, we have available at the present time for immediate use in the construction of a system of roads in this State $4,521,000. On July 1, 1919, another Federal-aid allotment of $874,000 becomes available, which, when met by an equal amount from the States makes available $1,748,000.

In addition to the above, the counties have raised by taxation a sum equal to that appropriated by the State for Federal-aid construction, or one-third of the cost of the Federal-aid roads, which is approximately $2,000,000; thereby making available for this year's construction $8,000,000.

Those who have had experience in preparing plans for road construction know that this means a great deal of work and will not only tax our department to the limit but will probably also tax our contractors to the limit providing all of this work is ready for letting in the immediate future, so it is plainly seen that we are not limited by lack of funds even though we do not touch the $60,000,000 bond issue funds this season.

There has accumulated in the State treasury over and above the sums already appropriated by the State, a free balance of approximately $2,500,000 and this amount is increasing very rapidly with the automobile registration and by the first of July probably another $2,500,000 will be added.

In other words, there will be available for road work over and above what has been appropriated by the State for State-aid and Federal-aid work, approximately $5,000,000. This cannot be used until such time as an appropriation is made by the legislature. The present plan is to use this accumulated sum in purchasing bonds from the sale of the $60,000,000 bond issue and retiring them immediately, thus obviating the necessity of selling bonds at 3½% to 4% interest on whatever amount can be taken up by the funds available. This, no doubt, can be worked out in some systematic manner.

Location of Bond Issue Routes.—The liveliest question at the

present time is that of selecting the exact routes on the $60,000,000 bond-issue system. The bond issue act states the building of a certain route begins at the State line east of Danville running southwest to Quincy, affording Danville, Decatur, Springfield, Jacksonville, Pittsfield, Winchester and Quincy reasonable connections with each other. The exact location of the point of beginning is left to the Department of Public Works and Buildings and it is not clear that each of those routes must pass through the towns named. By "reasonable connection," we might infer that the road could pass by Bloomington two miles to one side. That I believe has not so far come up for final decision.

The plan adopted by the Department is described in a circular letter, which we trust will receive wide publicity, requesting that every person who is interested in the location of a route between points named in the bill send to the Department a map or a carefully worded description of the proposed route. This should be sent in through the mail and not delivered in person as the results will be the same and a considerable expense will be saved.

Reconnaissance parties will traverse these routes and obtain data necessary to judge the merits of the routes so far as possible without making detailed survey. At several of the larger points there will be hearings on the location of the roads. At these hearings, all the people in favor of a certain route will be required to place their matter in the hands of a single spokesman who will be given 15 minutes' time in which to present the case of his particular district. It is the plan to confine these hearings to one spokesman for each possible alternative route between points named in the bill. When each hearing has been concluded the decision in most cases will be rendered immediately.

Of course very few people have considered the probable length and cost of the proposed routes. Distance is the most important element. At $2 to $3 per square yard, the cost per mile of the pavement alone runs from $20,000 to $30,000. The shortest route, therefore, is the cheapest, but is not always the route that is selected because service to the people will be given a very heavy weight, and also the cost of operating the road. By figuring out gasoline consumption on heavy grades, you will find some rather surprising things about the cost of operating the road, and another element taken into consideration is the distance to travel. To illustrate, should it cost ten cents a mile for operating a motor vehicle, with 500 vehicles per day, it would cost $50 per day and taking 300 days in the year, it would amount to $15,000 per year.

This would represent the cost of operating an extra mile of

distance; so it is plain to be seen that distance is quite an important element not only in the cost of the road but also in the operating cost.

Order of Construction.—The final plan as to order of construction has not yet been decided. We should follow that section of the law which reads that construction is to start as early as possible in all sections of the State at the same time. It does not, however, describe what is meant by a section of the State. It might be a county, half a county or one-third of a county. Several general plans have been considered but none have as yet been announced. It would seem logical to improve a continuous system of roads. The ideal plan perhaps would be to build continuous stretches of road that would connect up with previously constructed roads and keep a continuous system reaching out to the largest centers of population. This could not be followed ideally, of course, as there would be gaps and it sometimes happens that contractors are unable to complete their work in accordance with the contract entered into.

Beyond this, attempts to get detailed information concerning the location of roads and the order of construction seem to be occupying the minds of all the road boosters and road enthusiasts of the State of Illinois and it involves a great deal of difficulty. In order to avoid as much confusion as possible, we have advised people not to come to Springfield to take up these matters. Should all the people who are vitally interested in the location and order of construction of the State wide system of roads come to Springfield, it would require every moment of our time to hear these various delegations and the result would be that we would not accomplish anything.

Widths and Types.—The question as to what widths and types we are going to use on any individual piece of road cannot be answered until we know the exact location of a road, and this will not be determined until such time as the many important factors are given the most careful consideration.

The widths of roads are not to be less than 10 ft. nor more than 18 ft., except in certain cases where an extreme condition exists. In the main, however, we hope to build as many miles of double-track road as we reasonably can with the money available. It was estimated on a pre-war basis to build 4200 miles of roads with the $60,000,000 bond issue. The legislature added 600 miles without making any additional appropriation. Therefore we are expected to build 4800 miles whereas only 4200 miles was originally contemplated. It is evident that there will not be sufficient funds

to complete this system and we hope that the people realize this fact. It is the intention to lay out an adequate system so far as widths are concerned and where there is a double line of traffic we hope to build a double-track road. It is possible and permissible to build narrow roads where two lines run parallel to each other, but to determine the widths it would be necessary for us to have the data that the reconnaissance parties are working up.

As to types, we hope to build, in the main, rigid types of pavement such as concrete or brick or concrete base with bituminous wearing surface. We believe that rigid types will be demanded by the character of traffic that will develop along these highways. In the East, where improved systems of roads exist, it has developed that truck traffic increases very rapidly. It has been demonstrated that it is not economical to attempt to maintain macadam or gravel types of road under such large volumes of heavy traffic.

DISCUSSION

MR. NEWELL: What about prices? Is there any prospect of lowering them?

MR. OLDER: We have very little real evidence. It is the general feeling that while labor will not go back to pre-war basis, yet that for a reasonable wage we can find plenty of labor and so will be able to select it. As to materials, we haven't seen very marked evidence yet that we are going to get lower prices.

MR. HILL: Will you let contracts for a set price, whether a man is figuring on a small contract or a large contract?

MR. OLDER: This is a perplexing problem. We expect to let contracts in such units that they may be completed in one year. We have a five-year program ahead of us. A contractor would be reasonably safe in buying his equipment if he had a contract for only one year. If we let a contract now, he must bid on present labor and present material conditions. If we should let a contract for three years, the conditions are such that the contractor would probably make a good deal of money the second or third year. We want the State to get some advantage of the falling market if that is possible.

MR. SCHNEIDWIND: If a contractor gets through grading work in the spring, will there be any possibility of bidding on another?

MR. OLDER: The contracts we let this year will necessarily be on certain roads. Federal-aid roads are on certain lines and State-aid contracts are scattered all over the State. Contracts will be let on whole roads on the same day. The general plan of letting

contracts is to divide them so that a contractor may take a five or six mile section. The ordinary contractor finds enough trouble to construct five or six miles in one season. We expect to let contracts in units of sufficient size, and proposals will be worded in such a way that the contractor may take a five or six-mile section and go even farther and take several such sections if he is able. The proposals will be in such form that a contractor may obtain as much work as he will be able to handle.

Mr. Neighbour: What is your policy with regard to the roads that should have been built in 1918, and for which the funds are already available, and the people are clamoring?

Mr. Older: The district engineers have instructions to get their State-aid plans and specifications ready so that these contracts can be let this spring, if conditions are satisfactory for letting. A great many of the State-aid sections were surveyed a year ago but the work last year was limited because the price exceeded the estimates.

Mr. Summers: Has the Department determined yet whether the State, county or township will buy the cement, and at what point?

Mr. Older: The county or township will not in any event buy any cement to be used on road construction under the supervision of the State. As regards the purchase of cement for the Federal-aid roads, the matter has not yet been determined.

Mr. Rossiter: In view of the fact that the Government is very anxious that road work be pushed this year, should they not reduce freight rates on material and let us have the old rate?

Mr. Older: There is a hearing in Chicago today, including Michigan, Wisconsin and Illinois, with regard to freight rates. Of course there is a fight on with regard to these rates and we are against changes which would result in higher rates.

Mr. Newell: We all appreciate that the Government is operating at a loss, and we have got to have increased taxation. Prices are going to stay up. After the Civil War they stayed up for a long time, and it was due to the financial condition and not to other reasons. Prices are high because our gold dollar is worth less, and there is no probability of its being worth more. If that is true, we have no right to defer this work on a possibility of waiting six months or a year or several years for lower prices.

Mr. Hill: It is not so much a question of the cost of employment as it is the uncertainty of the cost of the employment. It would be unfortunate if our estimates proved too low. We should do all we can to get lower rates, but get some assurance from rail-

road direction that rates will not be advanced on road-building materials.

MR. NEWELL: Would it be possible to word the contracts in such a way that the State will bear the burden of the changes in rate? The contractor has to gamble on the prices, but the State can afford to take the risk of increase where the contractor cannot.

MR. ROSSITER: Is the Department taking any stand upon direct roadways, especially where a road is not laid out at the present time? A captain who came back from France reported that they had a direct line of roads from town to town, running straight through the towns.

MR. OLDER: Exact locations have been fixed only on a few roads. We have considered many suggestions for relocation. In the main, however, we cannot open up roads diagonally across farms. In regard to letting contracts in such a manner that the contractor would be relieved of changes in freight rates, last year we had a clause of that kind written in our specifications.

NATIONAL DEPARTMENT OF PUBLIC WORKS

A conference of technical societies held in Chicago in April, 1919, adopted resolutions to the effect that all services of the national government having to do chiefly with engineering and architectural work for the use of the public should be grouped into a Department of Public Works. Mr. Edmund T. Perkins was the official delegate for the Illinois Society of Engineers.

ENGINEERING LEGISLATIVE INFORMATION

The Engineering Council has organized a national legislative and departmental service for furnishing information as to technical matter on record in government bureaus, and also as to matters before Congress which involve engineering considerations. No charge is made for this service. Address the National Service Committee, the Engineering Council, 502 McLachlen Building, Washington, D. C.

FRED C. LOHMANN
(City Engineer, Champaign, Ill.)

President
of the

ILLINOIS SOCIETY OF ENGINEERS
1920

THE UNIVERSITY AND THE ENGINEER

BY PROFESSOR IRA O. BAKER

The University of Illinois is particularly glad to welcome the Illinois Society of Engineers, for you have been meeting here at intervals for about 34 years and we know that you are interested in what is going on here. The College of Engineering has an enrollment of 1714 students. In 1914 we had about 1200, and when we declared war with the Hun we had about 1150. But this increased attendance has brought us some serious questions. We have great difficulty to find instructors enough. In the College of Engineering we need 10 or 12 men; but we cannot get them because there is so much demand for engineers in commercial life and because we have not money enough to secure them when we find them. The amount we are paying for salaries now is only about 5% more than we paid 5 years ago, and we have 10% less staff than we had 3 years ago. The older men on our staff are staying, partly because of loyalty and partly because it is not easy for a man already rooted to pull up and go elsewhere. But the younger men, who are not rooted, are leaving, and that puts us in a serious situation.

I ask your attention to the fact that the University of Illinois is more than a teaching institution,—more than professors and students. We have gathered here a number of scientific bureaus and research organizations. In the College of Engineering we have the engineering experiment station, which has done some really notable work. It is not necessary to tell you about the noted researches that Professor Talbot has made on reinforced concrete and on stress in railroad track. The College of Engineering, with Mr. Layng, in cooperation with Professor Parr of the Department of Chemistry, has completed an investigation concerning the coking of Illinois soft coal and the regulation of by products. It is probable that this means the beginning of a new industry in America. One of the latest things we are doing is making some experiments about hot air furnaces, under the direction of Professor Willard of the Mechanical Engineering Department, and he is getting some valuable results. The latest thing undertaken by the Engineering Experiment Stationfi is concerning the fatigue of metals. The Engineering Foundation, on consideration that we furnish facilities and the scientific staff, has agreed to spend $30,000—$10,000 for each of three years—in an elaborate investigation on fatigue of metals. Professor H. F. Moore of the Department of Theo-

retical and Applied Mechanics, is to direct the work. One of the things most encouraging to the University is that when we have a problem, it is not difficult to get industrial and commercial interests to co-operate.

PRESIDENT'S ADDRESS

J. W. DAPPERT, PRESIDENT, 1919

The years 1917-1920 have been among the most important and momentous years of American history. The United States of America and its people have been transformed from a quiet, peace-loving nation, intent upon her own affairs, to a nation of world-wide influence. In the great world war and readjustment to peace conditions, the engineers of the United States have had a very important function, and have performed their part of the work most admirably. To all members of our Illinois Society of Engineers who have been engaged in war-work in any manner or degree (and I think t hat includes all of us) praise and great credit is due. We have frequently done such war-work at a sacrifice in salaries, wages and advancement, for the good of our country. We number amongst our members some of the brightest intellects in America and in the world today, and our Society is proud of its membership, and proud of the part our members have taken in national affairs, during the months of the great struggle, and in the period of readjustment following the great war.

There were amongst our members, two lieutenant colonels, five majors, six captains, eight lieutenants and seven non-commissioned officers and men serving in the United States Army, and mostly overseas. There were also at least ten other members who were engaged in war work exclusively, or for the most part of their time during the conflict. Among these, one was president of the United States Housing Corporation. At least three others were engaged upon U. S. Army camps and cantonments, while a much larger number were engaged upon works and in engineering projects closely related to the army, and essential to the winning of the war. There were thus engaged indirectly, yet in a very essential manner, no less than 221 other members of our Society. Also, our Society as an organization, subscribed $400 for Liberty Bonds and contributed $200 to the Citizens Unit and the War Committee of Chicago Technical Societies, and our members in an individual capacity subscribed thousands of dollars to the various Liberty Loans, and to the Red Cross and allied war relief organizations.

We ask all engineers and surveyors of the State to take notice of us, to investigate our claims and to come and join us.

We are not competitors of the national engineering societies, but we have our own important functions to perform as a State engineering society. Our Society is more like a community organization, we can get to know each other, we can tell each other our troubles, and we can ask for assistance and information among ourselves. We fill a very proper place in the economic welfare of the engineering structure. Consider the small cost of $4 or $5 per year, and only $2 for affiliated membership, and compare that with the benefits derived. A member can find who among us are specialists in certain lines and can get help from them in solving his problems. One additional duty that might be placed upon our secretary is that of maintaining a clearing house for this kind of work, to disseminate information, to bring together the members who know and the members who want to know.

Another benefit to members is the making of acquaintances, and the cementing together in bonds of good fellowship of the engineers of the State and the country. By working together, we enhance our value in the eyes of our employers. We gain more prestige and power with the public. We have more confidence in ourselves. The social contact and the mental stimulus gained at one of our annual meetings, and the general information and knowledge unconsciously absorbed, is alone worth all the cost, fees and dues required to carry along a membership. I find it worth a hundredfold the actual money cost to me.

Then among the benefits, I call attention to the published papers, discussions and reports of our Society meeting, and of the half-score or more society exchange reports. In these you get all the latest "kinks," newest methods and latest information covering a wide range of subjects in the engineering field. These reports and exchanges alone are worth a hundred fold the actual cost of membership. There is every argument why the young engineer, the new engineer and the older engineer needs our aid, our moral and material support, and every reason why, if he expects to progress, he should join our Society and become one of us.

RESOLUTIONS ADOPTED AT THE 1920 MEETING

1. *Cooperation.* The Illinois Society of Engineers will continue as a member of the General Committee of Technical Societies of Chicago and will cooperate as far as possible with that committee and with the other organizations comprising it. Further, the Society urges the General Committee to prosecute vigorously the following suggestions: A, arrange for competent and continuous representation at Springfield during the constitutional convention, and provide representation at committee hearings which have to do with engineering matters; 2, arrange to have representation at all hearings and conferences on city

zoning; 3, arrange for a special committee to study the engineering license laws of the various states with the object of revising the Illinois engineers' license law that it may be reciprocal with those of other states.

2. *University of Illinois.* This Society has always been deeply interested in the growth and development of the University of Illinois and is desirous of seeing it maintained at the high standard which has obtained in the past. Therefore the executive board is directed to appoint a special committee to represent the Society before the state officers at all hearings having to do with increasing the staff and operating income as well as increasing the salaries of the members of the present staff who have so faithfully served the University and the youth of the state during the past years.

3. *Topographic Surveys.* This society is convinced of the wisdom of rapidly completing the topographic map of Illinois and of the United States, as an essential preliminary economy in connection with road-building, river improvement, development of municipal water supplies, drainage of overflowed lands, and other important items of internal betterment. The society therefore recommends to the Governor and to members of the state legislature of Illinois that provision be made for a progressive increase in the rate of topographic mapping in cooperation with the Federal Government, with a view to completion of the work on or before 1932.

REPORT OF THE SECRETARY

The membership of the Society at the end of 1919 was 235, a loss of 22 since May, 1919. We have not heard of any loss by death, but one member has resigned and 15 were to be dropped for non-payment of dues during the past two years; in addition there are six members whose mail has been returned by the post office marked "address not known."

During the year, the Society has participated actively in some important movements, including the following: In March, the president appointed Edmund T. Perkins as delegate to two meetings in Chicago: one to discuss the establishment of a Department of Public Works as part of the Federal Government, and the other that of the National Committee on Engineering Co-operation.

In November, the president appointed T. N. Jacob and G. W. Pickels as delegates to the meeting of the National Drainage Congress, at St. Louis, November 11-13; with W. E. Putnam and E. E. R. Tratman as alternates. In December, the president appointed C. D. Hill as delegate to the Chicago city zoning conference, December 16-17; with W. D. Gerber as alternate. In December, the president appointed C. G. Elliott as delegate to the National Public Works Conference at Washington (January 13-15, 1920); with Isham Randolph as alternate.

The annual volume of "Proceedings" was well up to standard and had an exceptionally large number of advertisements. Three bulletins have been issued during the year, with information as to the Society's work, and have been sent to some 600 engineers throughout the State.

Exchanges of "Proceedings" have been made with the engineering societies of Connecticut, Iowa, Michigan, Minnesota, Ohio, Kansas and Wisconsin. No "Proceedings" have been received from the Indiana Society for two years. The Illinois Society's "Proceedings" have been sent to technical and public libraries as follows:

American Engineering Library	University of Illinois
Western Society of Engineers	University of Michigan

Cleveland Engineering Society	University of Wisconsin
Library of Congress	University of Chicago
U. S. Geological Survey	Northwestern University
Illinois State Library	Purdue University
Chicago Public Library	Cornell University
St. Paul Public Library	Washington University (Mo.)
John Crerar Library	Valparaiso University
New York Public Library	Vanderbilt University
No. Dakota Soc. of Engineers	Milliken University
Mass. Inst. of Technology	Armour Institute
Rose Polytechnic Institute	Lewis Institute

The expenses have kept pretty close to the receipts, as economies have been counterbalanced by higher prices. The largest items are the "Proceedings," bulletins and various printing matters, as shown by the accompanying financial statement. The Society being an incorporated body, the annual report of election of officers was filed with the County Recorder of Cook County, as required by law, the Society being registered in that county.

E. E. R. TRATMAN, *Secretary and Treasurer.*

FINANCIAL STATEMENT, DECEMBER 31, 1919

Balance in bank December 31, 1918 (exclusive of savings bank) $ 141.32

Receipts

Annual dues	$762.00	
Entrance fees	87.00	
Sale of Proceedings	5.50	
Advertisements	715.38	
Total for 1919		$1569.88
Total receipts		$1711.20

Expenditures

Printing and distributing "Proceedings"	$ 566.18
Printing stationery, "Bulletins," etc.	235.54
Stamps	71.72
Express and freight	31.02
Typewriting	26.90
Packing and distributing exchanges	25.75
Stenographer's report: 1919 meeting, Bloomington	51.00
Convention expenses; miscellaneous	6.88
Badges	19.15
Drainage Section, expenses for 1918	10.00
Tickets to Citizens Unit: for 108th Engineers	3.50
Secretary	250.00
Miscellaneous	15.10
Total expenditures	$1313.34
Total receipts	$1711.20

Bank balance, December 31, 1919	$397.86
Saving account reserve	329.41
Liberty Bonds	400.00

Total assets, December 31, 1919	$1127.27
Total assets, December 31, 1918	842.25
Due from members in unpaid dues ($104 by 28 members for 1919; $106 by 15 members for 1918 and 1919)	$ 210.00
Due from advertisers	None

PROCEEDINGS OF THE ANNUAL MEETING

The 35th annual meeting was held Jan. 21-23 in the Engineering Building of the University of Illinois, at Urbana, Ill.

January 21. Meeting called to order at 2 p. m. by the President, J. W. Dappert. After an address of welcome by Prof. I. O. Baker, and response by F. W. DeWolf, the annual presidential address was read by Mr. Dappert. Two papers were presented: "Dams at Jacksonville and Decatur," by S. A. Greeley (read by R. S. Rankin), and "The Illinois Waterway" by M. G. Barnes (read by G. W. Pickels). The president appointed the following: Committee on nominations; F. C. Lohmann, G. W. Pickels, W. D. Gerber; Committee on resolutions, I. O. Baker, M. C. Sjoblom, E. Bartow.

At the evening session a talk on "Modern Blue Printing Methods," with moving pictures, was given by A. H. Hopkins, of the C. F. Pease Co., Chicago. TheDrainage Section, with G. W. Pickels in the chair, had the following papers: "Engineers' Estimates for Tile Drainage," by J. A. Reeves, and "Illinois Drainage Laws," by E. A. Rossiter.

January 22. After a paper on "The Illinois Engineers' Licensing Bill," by M. L. Greeley, a statement as to "Engineering Cooperation" was read by G. C. Habermeyer, in the discussion of which Mr. Holcomb explained the work of the American Association of Engineers, and Mr. Gerber explained the purpose of the General Committee of Technical Societies of Chicago. Then the chair was taken by F. C. Lohmann, as chairman of the Roads and Pavements Section, and a paper on "Specifications for Brick Paving" was read by M. B. Greenough. At the afternoon session other papers were read as follows: "Pavement Surfaces for Modern Traffic," H. J. Fixmer; "Impact Tests on Roads," Prof. C. C. Wiley; "Good Appearance of Streets and Highways," Prof. F. N. Evans, and "Construction of Concrete Roads," K. H. Talbot (read by A. E. Holcomb).

The business meeting was then held, at which the secretary presented his annual report. The committee on nominations presented the following tickets, the figures indicating the votes cast by ballot: For president, F. C. Lohmann (19) and G. W. Habermeyer (9); for vice president, S. A. Greeley (21) and W. P. Bushnell (6); for trustees, G. H. Reiter (19), G. E. Burch (15), C. Older (12), M. L. Greeley (9). It was voted to hold the 1921 meeting at Chicago; no other place was nominated. The annual dinner was held at the Beardsley Hotel at 6:30, after which two illustrated addresses were given: "Engineering Problems of Water Supply for the American Expeditionary Force in France," by Lt. Cd. Edward Bartow, and "The Coal Problem, with the Handling and Storage of Coal," by Prof. H. H. Stoek.

January 23. Papers were presented as follows: "Sewerage Work at Fort Sheridan," H. R. Abbott; "Operation of Sewage Disposal Plants," M. C. Sjoblom; "Imhoff Tank Operation," W. G. Kirchoffer; "Storm Sewer Repairs at Danville," H. E. Babbit. A talk on "Structural Materials in Illinois"was given by F. W. DeWolf; and "Gravel Deposits of Illinois" by Mr. Leighton. President Dappert called on the new president, Mr. Lohmann, who made a brief address and then adjourned the meeting.

MEETINGS OF THE EXECUTIVE COMMITTEE

A meeting of the Executive Committee for 1919 was held Jan. 21 at the Beardsley Hotel, to consider the report of the secretary and treasurer. Plans were discussed for cooperation with other societies and for increasing the activities of the Society. A meeting of the Executive Committee for 1920 was held at the Engineering Hall after adjournment on Jan. 23, at which E. E. R. Tratman was elected secretary and treasurer, with salary of $250, as before.

CONSTITUTION AND BY-LAWS (Revised 1918)

ARTICLE *I*—NAME

This association shall be called the Illinois Society of Engineers.

ARTICLE *II*—OBJECTS

The objects of this Society are the encouragement of professional improvement and of goodfellowship among its members by meetings for the presentation and discussion of papers on scientific and other kindred topics pertaining to engineering, and the discussion of such other subjects as may be of interest to its members; the publication of such parts of its proceedings as may be deemed expedient; and the collection and preservation of books, maps, drawings, and other articles of value to the profession represented in its membership.

ARTICLE *III*—MEMBERSHIP

Section 1.—The membership of the Society shall consist of Members, Honorary Members and Affiliated Members. Members shall constitute the corporate membership of the Society and shall have the exclusive right to vote and hold office in the Society, but members of all grades shall have the right to vote and hold office in the various sections.

Section 2.—A Member shall be a person qualified either by education or experience to design, execute or maintain works of an engineering or public character.

Section 3.—An Honorary Member shall be a person of acknowledged eminence in some branch of engineering or science related thereto, or who has rendered some special service to the engineering profession or this Society. He may be elected to such membership by unanimous ballot of all the members, not less than twenty in number, present at any regular meeting of the Society.

Section 4.—An Affiliated Member shall be a person who may not be qualified for membership under Section 2, but who is interested in matters relating to engineering work or who is interested in the manufacture and sale of supplies and materials used in engineering construction or who is a student in residence in a college of engineering of recognized standing.

ARTICLE *IV*—ADMISSIONS

Section 1.—Each candidate for membership shall make application in writing to the Secretary on a printed form provided therefor by said Secretary. Such application shall give the name, age, place of birth, residence, present occupation and the nature and extent of professional services of the applicant and must give personal reference to three engineers, preferably members of the Society. Each application for membership shall be accompanied by the admission fee, which will be refunded if the applicant is not elected.

Section 2.—Application for transfer from Affiliated Member to Member shall be made in writing to the Secretary. Such application shall state fully the professional service upon which the request is based. No admission fee shall be required for such change in grade of membership.

Section 3.—Whenever any application for membership or transfer in grade is received by the Secretary, a copy thereof shall be submitted to the members of the Executive Board within one month from date of receipt. It shall be the duty of each member of the Executive Board within ten days from the receipt of the copy of any application, to send his vote upon the election to the Secretary. A majority of votes in the affirmative shall elect the applicant to membership. The Secretary shall include in his report to the Society the names and post office addresses of all persons elected.

Section 4.—A member of any grade may resign his membership by a written communication to the Secretary, who shall present the same to the Executive Board, when, if all dues shall have been paid, the resignation may be accepted.

ARTICLE V—DUES

Section 1.—The admission fees and annual dues for the various grades of membership in the Society shall be as follows:

		Annual Dues	
	Entrance Fee	First Year	Succeeding Years
Honorary Member	none	none	none
Member	$3.00	$2.00	$4.00
Affiliated Member	$2.00	none	$2.00

Section 2.—The annual dues are due and payable in advance.

Section 3.—Members whose dues are in arrears for one year shall receive the annual "Proceedings" of the Society but shall not be entitled to the "exchange proceedings" provided by arrangement with other socities.

Section 4.—Members whose dues are in arrears for two years and who offer no explanation for such delay shall be dropped from membership, provided, however, that the Executive Board shall have authority to remit such back dues and to continue such membership when in their opinion such action is justified by circumstances.

Section 5.—Every person admitted to membership in the Society shall be liable for the payment of all dues until he shall have resigned or have been dismissed by action of the Executive Board.

Section 6.—The fiscal year shall be coincident with the calendar year.

ARTICLE *VI*—OFFICERS

Section 1.—The officers of this Society shall be a President, a Vice-President, a Secretary-Treasurer and four Trustees.

Section 2.—The officers of the Surveying Section, Drainage Section and Structural Section shall each consist of a chairman, and three trustees, who shall constitute its Executive Committee. The officers of the Sewerage Section and the Road and Pavement Section shall each consist of a chairman, two vice chairmen and four trustees, who shall constitute its Executive Committee.

Section 3.—The officers of any committees shall be appointed by the President.

Section 4.—The management of the Society shall be vested in an Executive Board, consisting of the President, Vice President, Secretary-Treasurer, four trustees, the chairmen of the sections and the two latest Past Presidents.

ARTICLE *VII*—ELECTION OF OFFICERS

Section 1.—The officers of the society shall be corporate members and residents of the State of Illinois. They shall be elected by ballot by the corporate members during the annual meeting; and shall hold office until their successors have been elected, except the Secretary-Treasurer, who shall be elected annually by the Executive Board.

Section 2.—The President and Vice-President shall hold office for one year, and the Trustees for two years, two being elected each year.

Section 3.—The members of the Executive Committee of each Section shall be members of that section. They shall be elected by ballot by the members thereof at the annual meeting of the Society.

Section 4.—A vacancy occurring in any office in the Society may be filled by appointment by the Executive Board. A vacancy occurring in any office in a section may be filled by appointment by the Executive Committee of that Section.

ARTICLE *VIII*—DUTIES OF OFFICERS AND COMMITTEES

Section 1.—The President, Vice-President and Secretary-Treasurer shall perform the duties usually pertaining to their several offices. The President shall preside as Chairman of the Executive Board and the Secretary shall act as Secretary of the Board.

Section 2.—As Secretary, the Secretary-Treasurer shall be custodian of all the property of the Society and shall deliver all such property to his successor. He shall prepare an annual report concerning the affairs of the Society. He shall record the proceedings and discussions of the meetings and shall prepare a copy of them for the Executive Board. He shall be ex-officio librarian of the Society and as such shall collect and preserve all books, pamphlets, papers, and documents belonging to the Society and upon retirement from office he shall deliver all such property to his successor.

Section 3.—As Treasurer, the Secretary-Treasurer shall keep an account of the financial affairs of the Society and shall render a financial report of all receipts and disbursements at the annual meeting. He shall pay only such orders as are signed and approved by the President.

Section 4.—The Executive Board shall audit the accounts of the Treasurer before each annual meeting and shall render a report thereon to the Society at the annual meeting. The Executive Board shall be vested with the general conduct of the affairs of the Society and shall act on all matters concerning the Society between the annual meetings. It shall approve the execution of all contracts and the expenditures of all moneys.

Section 5.—The officers of the sections and committees shall be responsible for the programs of papers and discussions for their respective sessions, but all such programs shall be submitted to the Executive Board for approval. The Executive Board shall supervise the arrangement of the general programs for the meetings and of all committee and section programs, and shall set apart a certain time for their proper presentation of the latter to the members.

Section 6.—The Executive Board shall have the authority to create new sections or to discontinue any section whenever the Society will be benefited thereby.

Article IX.—Sections and Committees

Section 1.—Following the annual meeting there shall be appointed such committees as the Executive Board may deem advisable and necessary.

Section 2.—It shall be the duty of such committees to collect facts, figures and items of interest in their respective departments, and make a report to the Society at the next annual meeting.

Section 3.—To facilitate the study and discussion of special branches of engineering the following sections are created: 1, Surveying Section; 2, Drainage Section; 3, Structural Section; 4, Sewerage Section; 5, Road and Pavement Section.

Section 4.—Each section shall have the right to adopt rules for the transaction of its meetings, such rules to be subject to approval by the Executive Board of the Society.

Section 5.—No indebtedness shall be incurred by a Section without the permission of the Executive Board of the Society.

Article X—Publishing Annual Reports

The Executive Board shall compile and publish the annual report of the transactions of the Society. It shall include in this report all items of general interest in the proceedings, and such other matters as may seem advisable.

Article XI—Compensation for Officers

The Society may provide for the compensation of its officers for their services whenever deemed advisable, except that the compensation of the Secretary-Treasurer shall be fixed annually by the Executive Board.

Article XII—Amendments

All propositions for amendments to this Constitution shall be submitted in writing to the Executive Board for its review. The amendment, together with the report of the Board, shall be submitted to the Members within 60 days for a letter ballot. An amendment shall be declared adopted if the affirmative votes represent two-thirds of the total number of votes cast, not less than 50 members voting.

BY-LAWS

Section 1.—The annual meetings of this Society shall be in such place as shall be determined by the Society at each previous meeting, and at such time in January as shall be determined by the Executive Board. The Executive Board shall notify each member of the Society at least twenty days before the date of the annual meeting.

Section 2.—Ten members shall constitute a quorum for the transaction of business.

Section 3.—The meetings of this Society shall be governed by "Roberts' Rules of Order."

Section 4.—The order of business shall be fixed by the Executive Board.

Section 5.—A record of all donations to the Society, whether in money, books, maps, models, or other articles of value, with names of donors, shall be entered by the Secretary in a book provided for that purpose.

Section 6.—These By-Laws may be amended by a two-thirds vote of the members present at any annual meeting, not less than fifteen members voting.

REPORT OF COMMITTEE ON COOPERATION

Individuals cooperating secure results impossible to secure by independent effort. One person may cooperate with each of several groups which are attempting to accomplish the same or different things. Various groups may cooperate on one or several enterprises. Many members of this society belong to one or more non-technical societies and many belong to other technical societies. About 20% are members of the American Society of Civil Engineers. Many belong to the American Association of Engineers, a welfare organization recently organized on account of the neglect of welfare work by the older engineering societies. The membership of this new organization is increasing very rapidly. The American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the American Institute of Mining and Metallurgical Engineers and the American Society for Testing Materials have cooperated on certain specific technical matters. During the past few years they have cooperated in supporting the Engineering Council and through this council as well as individually are devoting more attention to welfare problems. There is now a demand from members of the organizations for closer and more effective cooperation.

A plan of cooperation under consideration by the above societies provides for societies such as this to have a part in the affairs of a joint national society which would consider national matters of public welfare. The component parts of this national organization would be: First, Local affiliations, preferably under the auspices of local engineering societies or clubs, as follows: A, Local associations or sections of the national engineering or technical societies; B, local engineering societies; and C, other local engineers and members of allied technical professionsand associates. Second. A national council, consisting of representatives of national engineering and technical societies and of representatives of local, State, or regional affiliations or organizations. The proposed dues for societies such as this are $1 per member, and representation proposed would be one person for a membership between 100 and 1000.

In 1909, the Illinois Water Supply Association was formed. In 1914 the members formed the Illinois Section of the American Water Works Association. The members of this section pay the regular dues of the national association and the section is allowed a certain maximum percentage of the amount contributed by its members for local expenses, stamps, notices of meeting, operation of lantern, etc. Many who were members of both organizations in 1914 have since

paid dues to one Society instead of two. Some of those who were members of the Illinois Water Supply Association only, became members of the national organization. Those who lived out of the state and who would not pay more than they had in the past for dues did not join the American Water Works Association.

During the war, engineering societies of Chicago and vicinity cooperated. There were 13 sections of national societies, two state societies and three local societies in the organization. Later, the Western Society of Engineers thought that much good could be secured by cooperation in times of peace, and they were successful in securing thousands of additions to their membership.

It would appear from the experiences of others that for the Illinois Society of Engineers the most effective method of cooperation would be to secure additional members, especially of mechanical, electrical and possibly mining engineers. There is apparently opportunity for securing many additional young members in civil engineering. Comparatively few of the members joining the American Society of Civil Engineers are members of this Society. It would appear to be good policy to join with other societies cooperating in work in which we are especially interested. A national organization would appear preferable. There appears, however, little advantage in forming an Illinois Society of Engineers section of a national organization where each member becomes a full member of that national organization.

Members of this society are at work as members of national societies on problems of cooperation. Professor Newell is President of the American Association of Engineers and J. W. Alvord is a member of a committee of the American Society of Civil Engineers appointed to consider a report on proposed cooperation. In cooperating with any national society we should consider whether we are primarily an organization interested in welfare, social or technical matters. We should consider proposals for cooperation of national societies and give suggestions should they not meet with the approval of this society.

J. G. MELLUISH (Chairman), J. A. HARMAN, G. C. HABERMEYER, W. W. DEBERARD, ISHAM RANDOLPH.

REPORT ON COOPERATION WITH THE GENERAL COMMITTEE OF TECHNICAL SOCIETIES

Since the war this organization has changed its name to the General Committee of Technical Societies of Chicago. The Illinois Society of Engineers should continue its membership.

There is an opportunity for all societies to cooperate through this General Committee in the development of a keener appreciation by citizens of the work of the engineer and also in the development within the engineer of a keener sense of his civic and political responsibility. A study of the various proposals offered at the constitutional convention with recommendations to the engineers of the state, together with the preparation of a new or revised engineers license law are activities which can well be undertaken by the committee.

W. D. Gerber, Delegate.

DISCUSSION

Mr. Lohmann: We need first to stimulate interest in our Society and next to enlarge our membership. There is a very wide field throughout the State, but we need to advertise our Society, which we have not done in the past. Nobody knows of the Society except at the time of its annual meeting.

The Secretary: That is not quite correct. Letters, application blanks and our occasional Bulletins are sent to about 600 engineers outside of our membership list.

Mr. Rossiter: For years the engineers in the employ of the city of Chicago pleaded for a decent salary. They saw that the bricklayer, hod carrier and driller could get their raise if the union went after it, so the city hall engineers joined the union. When a mayor, a governor or the President of the United States wants a commission to conduct a strictly engineering enterprise he appoints business men and lawyers. They hire the engineer. Is a drainage commissioner, a sewer commissioner or a superintendent of highways selected as an engineer? No; he hires the engineer, and it seems to me that the engineer should wake up and become the director of affairs instead of the hired man.

REPORT ON CITIZENS ZONE PLAN CONFERENCE

This Chicago conference was held Dec. 16 and 17, 1919, and was composed of delegates from more than fifty civic organizations, including the Chicago Association of Commerce, the Real Estate Board, Illinois Manufacturers Association, various architectural and engineering societies, women's clubs and improvement associations. The conference met in five sessions, and was addressed by such experts as: Robert H. Whitten, advisor, City Plan Commission, Cleveland; Herbert S. Swan, secretary, New York Committee on Districting; Edward M. Bassett, New York; Harland Bartholomew, city plan engineer, St. Louis; Thomas Adams, housing and planning advisor, Conservation Commission, Dominion of Canada; Ed-

ward H. Bennett, architect and city planning expert, Chicago, and C. B. Ball, chief sanitary inspector, city of Chicago. The various addresses and discussions set forth the merits of zoning not only as a measure of protection for residential districts from the nuisances of objectionable industries, but in a more material way as stabilizing real estate values and making ample provision for the development of industries and business in the cities where zoning is in effect.

The legislature of Illinois has recently enacted a law providing for zoning in cities of Illinois. In the opinion of the experts who addressed the conference this law is defective, as it encourages piecemeal zoning; that is, it provides that any portion of any city may be created into a zone having certain restrictions as to use, height and area of buildings, and provides further that no ordinance providing for such restriction shall be valid without a public hearing, of which all persons owning property within the district shall have formal notice.

It is the opinion of the above experts that it is impossible to plan successfully the zoning of portions of a city without taking into consideration the whole city and its environs, and that any attempt to create separate independent zones in different parts of a city without a comprehensive plan would be futile. Those who were familiar with the legal principles involved held that such an attempt would fail if tested in court on the ground that the legislation was discriminative. It was the opinion that any effective zoning law must be based upon police power and must cover the entire city, and while it is possible to create districts with different restrictions as to buildings and their use the same kind of restrictions should be applied to the same kind of districts anywhere within the city.

It is believed that the principle of zoning can be applied to small cities and villages with the same degree of benefit as it can be applied to larger cities, and that it is for the interest of the inhabitants of all municipalities within Illinois to give serious consideration to the problems involved, to take advantage of the present law to the extent of appointing commissions to make studies and surveys of existing conditions, and to make application to the legislature for such changes of the law as are necessary to carry out its purposes.

C. D. HILL, W. D. GERBER, Delegates.

LICENSING OF ILLINOIS SURVEYORS

BY M. L. GREELEY

The surveyors of Cook County have for many years felt the need and desirability of a registration law, licensing sur-

veyors. Many attempts have been made in the last 30 years to obtain a registration act covering the State of Illinois, but have always been defeated because of the antagonism of the down-state surveyors and engineers.

Last year, the Surveyors Association of Cook County presented a bill for the registration of surveyors in all counties of over 250,000 inhabitants, which limited the scope to Cook County. This bill had the hearty endorsement of the Cook County recorder, the chief examiner for the Torrens system in Cook County, and the president of the Chicago Title & Trust Co. It received almost no opposition during its progress through the two houses and became a law on June 28. We had expected the operation of the law would be administered by the State Department of Education and Registration, but as the law only affected one county, the Department declined to function, so the operation was put in the hands of the recorder of Cook County. The bill provided for an examining and registering board of three members, the recorder being ex-officio chairman and member. The other two members must be land surveyors and be appointed by the county judge.

(Sec. 11). The Board is given the power to revoke a certificate of registration for (a) obtaining a certificate by fraud or misrepresentation; (b) incompetency or carelessness; (c) misuse of seal. This gives the Board the opportunity of weeding out incompetents after due public hearing. (Sec. 16). The law permits the surveyor to take evidence under oath of witnesses in establishing any fact of any survey. He may take and attest by his seal the acknowledgments of plats and other documents relating to real estate. (Sec. 17). All plats and certificates thereto under the hand and seal of a licensed surveyor shall be received in evidence in all courts in this state and shall be entitled to be recorded in the county wherein the land affected thereby lies. (Sec. 18). The Board shall issue permits to surveyors of other states to practice within counties affected by this act, when they present credentials showing that they have been registered under laws of their own states. The Board extended the privilege of obtaining a license without examination to surveyors of other counties than Cook county upon proof that they had been established in business as principals for five years.

The sponsors of this law feel that it gives a dignity and recognition to the profession of surveying which it has not engaged heretofore. The fact that the plats and certificates of a licensed surveyor are admissible in evidence in all courts without his having to prove them in person is a distinct advantage and puts him on an equality with the county surveyor.

In a number of states registering laws have been enacted in which the surveyors have been included with the architects and civil engineers. This is always to the disadvantage of the surveyors. In no case so far as I know are they represented on the board of examiners. This the surveyors of the Cook County Association believe is a serious mistake, as the engineers and architects are not informedas to the needs and requirements of the surveyor's profession, nor are they informed as to the laws, rules and methods governing surveying, and therefore are not qualified to pass on their competency. We object to being included in the legislation instigated by engineers, and not recognized in its drafting and administration; it is like taxation without representation.

I recently called at the headquarters of the Western Society of Engineers to see the laws of various states on the registration of engineers and surveyors, only to find that they did not have them in their files. That society has commodious quarters and a large library but it had never occurred to them to compile the laws of the country controlling the engineers' activities. I found in an engineer's office a draft of a uniform law for registering architects, engineers and surveyors, drawn by a committee of 15 members from the Engineering Council. This law, if adopted by the Council, it is proposed to have introduced and passed by all State legislatures. The engineer who was chairman of the committee told me the personnel of the committee represented all sections of the United States from the Atlantic to the Pacific and they had spent 15 months in drafting the bill. They had consulted many others about its provisions and he was satisfied that they had finally devised an ideal law which, if passed, would work to the advantage of all concerned.

He assured me the surveyors were well taken care of. I asked if there were any surveyors on the committee? No, there were not. Did the committee consult any surveyors while drafting the law? No, they did not. In the law as drafted, was any provision made for surveyor members on the examining board? No, there was not. He did not know that there was such a body as the surveyors' association of Cook County. He had never seen the law passed last June by the Illinois General Assembly, registering surveyors in Cook County. And yet he thought his committee had given the surveyors a square deal. Section 16 of this proposed bill reads as follows:

"Land surveying as covered by this act refers only to the surveys for the determination of areas or for establishing or reestablishing land boundaries and subdivision of land. Nothing in this act shall be construed as prohibiting registered

engineers or registered architects from making land surveys where such surveys are essential to engineering or architectural projects."

This sems to give the engineers and architects the right to make land surveys. This the surveyors object to, feeling that neither profession is qualified to do so. The exception should be that engineers and architects are not prohibited from running lines or levels required in the projects they are engaged in, but the establishing of the property boundaries should be made by a registered land surveyor. If this bill is adopted by the Engineering Council it is probable that they will ask for the endorsement of this Society, and it is my hope that the Society will then help the surveyors to get a square deal, which they are not getting in the bill as drafted. I think the surveyors are largely responsible for this attitude of the engineers in ignoring them, as they have not been sufficiently aggressive in asserting their own rights and responsibilities.

PAVEMENT SURFACES FOR MODERN TRAFFIC

BY H. J. FIXMER

The design of pavement surfaces for modern traffic merits more careful attention than is generally given to it. The value of the pavement to the users must be considered of paramount importance. The ideal pavement surface must prove safe and comfortable to use, must be truly economical and present an agreeable appearance. We must consider not only the effect of the traffic on the pavement, but the effect of the pavement surface on the user. We must design our pavement surfaces to fit the needs of the traffic. A pavement is judged by its surface.

There are three general classes of traffic: pedestrian, horse drawn and motor. In some instances one or possibly two classes of traffic may be ignored, but in the typical town or city street all classes must be given due consideration. Since all these classes have a right to use the street, the ideal pavement must be designed to afford each class the maximum comfort and safety without interfering with the right of comfort and safety of the others. On a given street the relative importance of the various kinds of traffic must be determined. Since horse drawn traffic is slowly but surely decreasing, less attention need be given to accommodating this traffic. Modern traffic may be consideredto consist of pedestrians and motor driven vehicles.

Provision must be made for pedestrian traffic at all street, alley and private driveway crossings. Comfort and safety are secured by eliminating steps as far as possible,

avoiding gutter openings in the path of traffic, providing a smooth surface as nearly straight and level as practicable, and keeping the crossing clean and dry.

Considerable study has been given this subject in Chicago in recent years, and it is believed successful if not ideal results have been achieved. On streets designed by the writer the usual step from the abutting sidewalk to the pavement surface has been eliminated at all alley, private driveway and street crossings in residence districts. On business or through traffic streets, considerations of safety and the greater importance of vehicle traffic modify the general plan. On all street, alley and driveway crossings along such a street the pavement is built even with the sidewalk for a distance of at least 6 ft. nearest the building line. A step of from 5 to 7 in. is made at the curb adjoining the crosswalk crossing the busy street. By eliminating the steps along the street the maximum pedestrian traffic is accommodated with little interference with the comfort and safety of the slow moving cross vehicle traffic.

The step at the crosswalk crossing the business street permits the pavement surface to be carried through on a nearly level grade, which accommodates the maximum vehicle traffic. The presence of the step tends to cause the pedestrian to hesitate (and look) before crossing the busy street. Where the street is of unusual width or carries a great volume of fast moving traffic a safety island is often built, being usually 4 ft. wide and 6 in. above the pavement surface. Where two car line streets intersect, the usual step at the crosswalk is eliminated, since all vehicle traffic must slow down in crossing, and because the large pedestrian traffic at this location demands a comfortable crossing. Where a vehicle is traveling less than 15 miles per hour the slight raise in the pavement surface occasioned by the so-called "flush crosswalk" causes no inconvenience or noticeable jar.

The matter of a smooth surface at street crossings was early recognized. In the old granite block pavement crossing slabs were laid. In the old macadam pavement brick crosswalks were built. In the typical village or small town the first street improvement generally consists in building a plank, stone or concrete crosswalk. Time has proved them very undesirable as they soon become uncomfortable and even dangerous to vehicle traffic. Since modern vehicle traffic requires a smooth surface, it is found that a modern pavement agreeable to such traffic is satisfactory to foot traffic.

The crossing should be as level as is consistent with the contour of the pavement and with surface drainage. This means a fairly flat crown. The crossing should be clean and

dry. By reason of paving the crossing even with the sidewalk, with a low crown and slightly increasing the slope of the gutter away from the crossing, the crossing keeps clean and dry automatically. Where a step is necessary it is a refinement worth while to increase the gutter slope across the crosswalk to enable the gutter water to pass without depositing any refuse at the crossing.

Little consideration is now given to horse drawn traffic in the city except at grades and at localities of heavy trucking. The horse is little used for pleasure driving and since he travels slowly the demands of comfort and safety are of little weight. For horse drawn traffic the pavement surface should be fairly smooth, non-slippery and on all grades and loading areas afford a good foothold. A resilient surface is recognized as better for the horse, but since he is gradually disappearing from general use it is advisable, as a general rule, to ignore his peculiar needs. Motor traffic, both pleasure and trucking, is the type of vehicle traffic we must design our pavements to meet. Comfort and safety must be secured. The surface should be smooth, of adequate width and affording low tractive resistance. It should have a low crown, easy grades, easy turns and an agreeable appearance.

A smooth surface implies freedom from surface irregularities such as appreciable joints and cracks; uneveness due to surface wear or disintegration; uneveness due to debris dropped or accumulated, settlement of the structure underneath, and contour unevenness due to raised crossings, change of grade, and crown slope not adapted to the location.

Width is usually determined by the amount of money available rather than a careful analysis of the amount, kind and speed of the traffic expected to use the pavement. Subsoil drainage, preparation of the subgrade and design of the pavement structure are distinct from the design of pavement surfaces, but their function is to secure and maintain a smooth surface. To have a good surface the pavement must be properly repaired, maintained and cleaned. The importance of cleanliness is obvious in the city, but it is likewise important on country roads, from other than reasons of sanitation and appearance. A clean surface, being non-slippery, promotes safety. Recent experiments have shown that irregularities of surface due to unevenness and foreign material dropped by passing vehicles or even accumulated refuse, induce, by increased impact, excessive strains in both the surface and pavement structure. A pavement properly maintained and cleaned, apart from increasing its life, safety, comfort and agreeableness to the user, can carry at least twice the load that a neglected surface can.

A pavement should have as low a crown or cross slope as conditions will permit in order to encourage full use of the surface width. At intersections the crown should be carried through without inconvenience to the vehicle traffic on the more important street. The character of the surface should be varied to suit special conditions. In front of schools, libraries and hospitals a quiet surface is appreciated. On grades a surface that will give good traction, and possibly good foothold, is needed. At turns where proper elevation cannot be secured it is often advisable to use a gritty surface and keep it clean. In other words, on any improvement the character of the surface, like the depth and strength of the pavement structure, must be adapted to the locality and to the requirements of the users. Large radius corners should be used, as they promote safety, reduce congestion, reduce curb breakage and add to the comfort of the user. Abrupt changes in grade should be connected by vertical curves. Horizontal curves to be of large radius on through streets and properly eased at the tangents. Proper lighting, tree planting and street and route markers, add to safety, appearance and comfort.

Pavements that have a smooth surface, or can be easily maintained and cleaned, may be arranged in the following order: 1, sheet asphalt on concrete base. 2, asphaltic concrete on concrete base. 3, brick with asphalt filler and concrete base. 4, concrete with asphalt filled joints and cracks. 5, creosoted wood blocks as usually laid. 6, sandstone blocks with grout filler. 7, granite block with bit mastic filler. 8, brick or granite with grout filler. 9, brick or granite with tar filler, 10, asphalt macadam; 11, waterbound macadam. 12, clay gravel surface. The foundation structure should be designed to fit the traffic and character of the sub-grade. Its function is to support the surface. The surface should be designed to fit the needs of the location and the users. And these needs are, may it be repeated, comfort, safety and appearance.

IMPACT TESTS ON ROADS

BY C. C. WILEY

There is probably no detail of pavement design receiving anything like the attention at the present moment that is being given to the determination of the thickness and make up of the slab. This is as it should be, for by building too lightly we can waste enormous sums in maintenance and reconstruction and by building too heavily we can work another great waste in time, labor, materials and equipment at a time

when they can ill be spared. And since the cost of right of way, grading, etc., is nearly independent of the pavement detail it is evident that aside from the width of slab it is the thickness that controls the expense.

Impact allowances on highway bridges are generally determined by the same rules as for railroad bridges, and the question might well be raised as to whether our highway bridge designs may not need some revision in view of the results being obtained on the actual impact of moving loads on highways. With present speeds, loads and prices, design of pavement becomes important, and the U. S. Bureau of Public Roads has undertaken the study of impact on roads.

If we assume that a subgrade is incompressible, then the only result of a load is to put compression into the slab, but if the subgrade is compressible, or for any reason fails to support the slab, then internal bending stresses are set up whose magnitude is dependent on the amount of load, the thickness and character of the slab, and the conditions of support. For simple beams and slabs the solution is not difficult, but for the complex conditions affecting a pavement recourse must be had to tests to determine the factors. Numerous measurements were made but the most significant is that with a wheel load of 8500 ℔ on an 8-in. concrete pavement supported on a subgrade of wet clay of low bearing capacity the fiber stress in the concrete amounted to but 34 ℔ per sq. in. or about 1-15th of the ultimate strength of the concrete. This load is about equivalent to that of the rear wheel of a 5½-ton truck. If this is true, is it necessary to build a slab 8 in. thick? If not, why do we do it? If it is, impact must be the answer, at least to a considerable extent. Specific problems before the investigators are: (a) The amount of impact delivered to the road surface by different vehicles under different conditions, and (b) The effect of this impact on different types of road surfaces.

A concrete box was built into the road, in which was placed a contrivance similar to a hydraulic jack, the plunger of which carried a plate to receive the truck wheel. Auxiliary parts enable the front wheel to be carried over this plate and then cleared so that the impact from the heavier rear wheel would be secured. To measure the impact, cylinders of pure copper were used, carefully machined to ½x½ inch, specially heat treated and calibrated in a testing machine.

One of these cylinders was placed under the plunger of the jack which received the impact of the wheel, and then the deformation of the cylinder was accurately measured. Knowing the static load to give various deformations, these measurements indicated the impact load in terms of the static

load. In some instances the wheels were permitted to drop abruptly onto the plunger plate, in others obstructions were placed on the plate and run into by the wheel, and in others wedge-shaped plates were used, the wheels either being permitted to run over the wedges or to jump onto them from a take-off, thus simulating the running through or dropping into a depression with sloping sides.

The frame, motor, body, and load of the truck rest on springs supported on the axles and is here termed a "sprung" load. The weight of the axles themselves, lower parts of the springs, the wheels and part of the drive mechanism is carried directly to the road without the intervention of springs and is termed the "unsprung" load. When unloaded a spring has a certain neutral shape. As load is applied it is deformed, having a tendency to come back to neutral shape.

A wheel dropping suddenly into a shallow depression will strike with the full effect of the unsprung weight backed by all the kick of the spring, the inertia of the sprung weight carrying it along so as to contribute comparatively little to the impact. As the depression becomes deeper the effect of the kick becomes less and of the sprung load more, as it is following the wheel down and must be picked up and supported by the springs in a short period after the wheel strikes. At some depth the effect of the unsprung weight will be neutralized by the rebound of the spring and the impact of course greatly modified. At greater depths the impact will be due only to the falling of the gross load modified by the easing action of the spring on the sprung portion. The resultant rebound of the spring will cause a series of secondary impacts of decreasing amounts at points depending on the period of the spring and the speed of the truck. So far as I can learn only the initial impact has been studied and the others are probably much less.

A series of tests was run with a 5-ton army truck, having a gross load on one rear wheel of 7750 ℔, of which 1837 ℔ was unsprung. Incidentally this was a high proportion of unsprung weight. In general the impact increased somewhat with the speed and amount of fall. The impact due to striking an obstruction running over an incline or striking an incline after a jump were much smaller than for a direct sudden drop and showed a proportionately greater increase with speed. For a direct drop the maximum impact was secured with a fall of 3 in. at a speed of 15 miles per hour. The impact load in this case amounted to 42,000 pounds or 5.4 times the static load. Since the stress in an 8-in. concrete slab for this static load is about 30 ℔ per sq. in. the effect of

impact is to increase this stress to about 170 ℔, or to about 1-3 the ultimate strength.

Owing to the spring action the impacts for small drops were relatively high. This truck gave a value of 28,000 pounds or 3.6 times the static load for a drop of only ¼-in. at a 15-mile speed. As drops of this amount are by no means uncommon, as for example between adjoining slabs, over car track rails, etc., it is evident that this is worthy of note in the design. It serves also to show the importance of eliminating the small depression which is perhaps worse proportionately than the big one. The impact against an incline increases with the slope, as would be expected, and consequently depressions of easy slope are less important than those more abrupt.

Tests with a 5½-ton truck having a gross wheel load of 8060 ℔ and an unsprung load of 1000 ℔ showed the same characteristics of impact, but the impact values were materially lower, explainable only by the lower unsprung weight. Tests with a 1½-ton truck having a wheel load of 3475 ℔ and an unsprung weight of 1065 ℔ showed also the same general characteristics of impact but of course considerably less in magnitude.

Impact has been said to vary with the square of the speed and while the data available are not sufficient to indicate the true relation they do indicate that the variation is something less than the second power. Again, the tests show that the impact does not vary directly with the drop but is modified by the ratio of sprung and unsprung loads, making it probable that trucks of different types and build may give entirely different impacts although carrying the same gross load on the wheels.

The application of the results of these tests may lead to some decided changes in the design of road slabs, especially those of concrete or monolithic brick. The theory of static loads indicates that the strength of a beam varies with the square of the depth. This theory has been applied in comparing different slabs for strength. It was used by the writer in his slab tests, and by the Illinois Highway Department in making the comparative designs of different pavements. On the other hand the theory of impact indicates that the strength of a beam varies directly with the depth. Since the action of springs, tires, etc., probably modifies the impact it would seem probable that the true relation for strength is some function of the thickness of the slab lying between the first and second power.

The second part of the tests is to determine the effect of impact on different types of roads. For this purpose sample

sections of many types have been built, half of them on a dry, well drained subgrade and half on an artificially saturated subgrade. A special impact machine to imitate the action of the rear wheel of a 7½-ton truck having a gross load of 12,000 lb of which 3000 lb is unsprung will be used in testing these sections.

Since it is evident that impact does exist, and is of sufficient magnitude to warrant its consideration in the design of the pavement, is it not of equal importance to the designer of the truck? Should not every effort be made to have the truck builder realize this and to so proportion his sprung and unsprung weights to lessen the damage to both truck and road. And does it not seem that these tests shed some light on an equitable basis for truck license fees and the framing of legislation regulating truck sizes, weights and loads, which may be the making or the breaking of motor transport.

THE APPEARANCE OF STREETS AND HIGHWAYS

BY PROFESSOR FREDERICK N. EVANS, UNIV. OF ILLINOIS

Looking at the subject in a broad way, we will see that the appearance of streets and highways is dependent upon four things, (1) the character or type of street system used, (2) the type of street as regards its use or purpose; (3) the regulations governing structures major and minor, along it, and (4) regular street equipment. To a greater extent than is ordinarily supposed, does the type of street system govern a street's appearance. There are four principal kinds of systems, the irregular or meandering, the concentric, the radial and the perpendicular (commonly called the gridiron or checkerboard). Seldom is any one type used alone in the town plan, even the widespread perpendicular system usually being broken at some points by highways leading in from the country.

Obviously the way in which the appearance of the street is most particularly affected by the type of street layout used is in the control which the type exerts in terminating the view, or in necessitating or obviating cut and fill in construction. Both the irregular and the concentric type close in the "street picture." In residential subdivisions the curving street line adds to the appearance of the street. It is understood, however, that uneven topography is the best excuse that a street has for curving, and that on flat ground street curves are apt to appear out of place and forced. Radial streets offer numerous opportunities for the interesting termination of vistas at street junctions, as seen in Paris, and in a few of the cities of our own country. The lack of termi-

nation in the perpendicular system, (quite deservedly bearing the name "American system" abroad) is a well known fact, thugh there are exceptions to this, when the straight street is not carried quite over the horizon.

The appearance or character of a street differs according to use. Streets serve various purposes, for instance, there is the arterial thoroughfare, including broad avenues and highways, the street in the wholesale and industrial sections, the street in the retail district, the main residential street, the minor residential street, the parkway and boulevard, and finally the alley. Standardization of street width over the entire town plan has led to great economic loss—a condition which might be largely obviated. Where the use of a particular street may undergo possible change, the distance between curb and sidewalk may bemade wide enough to allow for the future widening of the street pavement. A suggestive and helpful diagram of street cross sections for various types of streets is that in Vol. II of the Report of the U. S. Housing Corporation, published by the U. S. Department of Labor, being an especially valuable reference in suburban land development. With the regulation of building heights, front building line restrictions in residential neighborhoods and efforts working for the elimination of signs and billboards, we are already familiar. The effect of such regulation upon the appearance of the street is at once apparent. Closely related to this effort at cleaning up the unsightly is that of doing away with poles, wires, encroaching steps, and such things, including also advertising clocks standing near the curb. Besides the effect on traffic movement, and insuring greater safety, there is exerted a wholesome effect upon the appearance of the street.

All will probably agree that the pavement should be made no wider than is necessary to accommodate traffic along it. If width in appearance is desired, getting it by putting down an expensive pavement is a costly method. It can be gained effectively by having a narrow pavement and ample parkings, by putting in a center parking, or by keeping trees off the parking entirely and planting them just inside the property line. At Cleveland, Ohio, the Shaker Heights Improvement Co. put in a number of streets having the pavement but 26 ft. wide, side parkings of 11 ft., sidewalks 5½ ft., and with one- or two-foot reservations on each outer edge between sidewalk and property line. These streets appeared impressively wide after construction, and the paving costs were low.

Too often the center parking, instead of functioning as a part of the street, appears merely as a narrow green rib-

bon. It ought to be as wide or slightly wider than the roadway on either side. Nothing should be placed in it which will give the effect of dividing the street in half. Generally trees in the center parking would seem permissible only if there are trees of good height in the side parking. An exception is when the parking is wide enough to carry a walk down its center, as on Commonwealth Avenue, Boston. On narrow parkings, light standards, high shrubbery, or other prominent street furniture will surely narrow the apparent width of the street. What is placed in the center parking, then, should be kept low.

Grass gutters or gutters of stones with grass edges are appropriate for streets of suburban character. The difficulty lies in keeping the edges from growing ragged and from being cut by wheels which draw close to the roadway border. The benefit of giving the curb a generous radius at the corners is generally recognized, particularly in subdivision work, where in residential sections it is the aim to get away from mechanical appearance. We find that from 4 ft. the curb radius has increased to about 20 ft. The handling of the side parking is extremely important, since by means of a genuine parking, even a narrow roadway may be used without constructing the effect of breadth. No side parking should be under 4 ft. in width, this being the minimum for street tree growth. Parkings between curb and sidewalks are sometimes omitted without such disastrous effect to appearances as might be imagined. This is to be done only on narrow residential streets, and of course on those in the downtown district. Sidewalk widths vary according to the use expected of them. Two feet is a proper width upon which to base calculations for each line of foot traffic. In residential sections 4 ft. is about the minimum and 6 ft. the maximum for ordinary use. Considerable leeway may be allowed for variation of height of sidewalk above the pavement. Pleasing effects are thus secured, such a change from the regular way being economical as well as attractive. Trees are on the boundary between necessity and ornament. They should be of uniform size and variety along each street, and are best planted about 40 ft. apart. At corners, it is of benefit to traffic safety and to appearance to keep trees back about 20 ft. from each corner. This gives a wide circle of eight trees instead of the usual four, adding a good deal to the dignity of the street. By the form of its lighting standards, street name signs, post boxes, and many other pieces of street furnishings the appearance of the street is directly affected. It is a simple law of attention that the eye tends to pass over broad surfaces and come to rest upon small prominent objects. Important,

then, is the form to be given these minor objects of street equipment. Each one in whose hands lies the placing of such equipment should allow his desire for doing the individual thing to be tempered by conformance to what is restful and dignified rather than what is odd and startling. It is hard to define good taste, but it seems to consist largely in doing simple things well, doing them frankly, and basing choice upon the best of what has been done in the past.

NATIONAL HIGHWAYS

BY EDGAR A. ROSSITER

National highways for motor vehicles will be one of the engineering problems for the coming decade. With each improvement in the construction of roads came the ever increasing load, until now the 10-ton truck at 10 to 15 mile speed is not unusual. Will we in a few years have a 15 to 20-ton truck and must we design our construction to meet such conditions? Will concrete, brick and macadam roads we are now building stand up against the heavy truck traffic of the coming years? This seems to me a question of vital importance. Supposing we construct concrete or brick roadways at $25,000 per mile and in five years find that the truck traffic is pounding them to pieces. Would it not be a wise proposition to stop now and consider and possibly pay a little more per mile for something that is everlasting?

Your first French lesson in road construction will be the straight lines between towns and cities. When you figure the initial expense of construction per mile, the maintenance, the wear and tear on roads and vehicles, the cost of gasoline or motive power, the more direct lines for roads are by far the most economical. In America we frequently go 160 miles around when the direct route is but 100 miles; this is not the French way. The next lesson is that a good road will cost real money and a cheap roadway is better left unbuilt. The part of the road you cannot see is the most expensive, that is the foundation.

The Government will have on hand from 150,000 to 200,000 trucks and trailers of 3½ to 7 tons when our troops return. The question will be, what to do with them? The most feasible plan would be (if we had a good system of roads) to establish post or express routes covering the entire country. The farm products that could be carried from farm to town would pay for for the maintenance and give a large return on the investment. Under the old system the farmer, who is five or six miles from the railroads, will not ship his produce, neither will he raise special truck for city consump-

tion. But with the concrete or brick roadway, a distance of 25 miles can be covered in the time five miles are now traveled.

With a general national highway system through the various states the question of routes is of great importance. A highway that leads to, but not through a village or city is desirable. As you approach a village the intersecting streets become more frequent, which requires a reduction of speed, and in passing through a town the danger of collision increases.

STANDARD SPECIFICATIONS FOR BRICK PAVEMENTS

BY MAURICE B. GREENOUGH

The pavingbrick industry through its association, has had the privilege since 1906 of placing in the hands of engineers and public officials specifications for brick pavement construction. Those first issued provided for all types of brick pavements. They covered concrete, rolled stone and gravel bases, No. 2 paving brick bases and natural soil foundations. Fillers were sand, bituminous and cement grout. The bedding for the brick was sand. It must be recalled, however, that in 1906 very much less attention was paid to subsoil drainage. The weakened condition of foundations saturated with water, overlaid by a pavement with sand and bituminous fillers produced a temporarily unfavorable attitude among engineers. The great demand east of the Mississippi was for the cement grout filled pavement on sand cushion.

The last previous revision of the specifications followed the bringing out of the green concrete foundation type and the semi-monolithic type. The time has come, however, when a complete revision and co-ordination of all the specifications is needed to align the industry with the progress of engineering thought in brick pavement design and construction. There is no type for universal use. Flexibility of type is a distinct advantage to the public and this is the keynote of the new specifications.

By far the greater proportion of brick pavements laid up to 1895 were filled in the joints with sand or bituminous material. For many years they were laid on natural foundations. Artificial bases had their inception in the belief that thus imperfectly drained or consolidated subgrades might be bridged over and settlements in weak spots prevented. The cushion or bedding beneath the brick primarily was intended to compensate for unevenness in the surface of the base. Sand and bituminous fillers continued to be used after the construction of artificial bases became general. At the time there had not been developed a bituminous filler that could meet the

much-specified requirement that "it shall not flow in hot weather nor become brittle in cold weather." The result was that, as soon as the filler had left the joints, the edges of the brick cobbled and pavements then became noisy.

The development of cement-grout-filled brick pavements grew out of these conditions. It was thought this would protect the edges of the brick, a sanitary surface would be provided, and the firm bonding of each brick to its neighbor would furnish a monolithic wearing surface. It became apparent, however, that in pavement as built under average working conditions the sand cushion was a tricky and dangerous element. Uniform compression was the exception rather than the rule. Patches of the surface have been broken down and by many this was attributed to defective brick. The real cause was in an imperfectly compacted sand cushion.

The solution seemed to be found in the development in 1914 of the green concrete foundation type and the semi-monolithic type of brick pavement. The belief that the principal merit of these two types lay in the elimination of the hazard of the sand cushion has been justified. While longitudinal cracking common to the sand cushion type in frost latitudes, has not been eliminated, it has been reduced. It was further believed of these types that the unit structures would bring about increased stability and economy in design, as compared with the sand cushion type. So far the discussion has been confined to the country east of the Mississippi river. In its early brick pavements the west followed eastern precedent and used the bituminous fillers or sand to a large extent. Being in the field of asphaltic oil production it naturally turned to asphalt filler and while the east turned from bituminous to cement grout filler, the west persevered in its endeavor to improve its asphaltic filler. About 1912 it could definitely be stated that a filler had been found that would not flow in hot weather nor chip out of the joints from brittleness in cold weather. It would remain in the joints with apparently no loss of vitality that could be discovered over a period of years. It did afford the desired protection to the edges of the brick. It met the requirements for quietness and sanitation. This asphalt filler, as improved, has been adopted in the specification of the National Paving Brick Manufacturers' Association and also by the Asphalt Association.

Prior to 1895 nearly all brick laid measured $2\frac{1}{4}$x4x8 to 9 in. They were plain wire-cut and unrepressed. They possessed beyond question unequalled wearing qualities, but in response to a desire for brick of more perfect shape, the paving brick industry produced the so-called block size, $3\frac{1}{2}$x4x8 in., and with this came the addition of projections or lugs for

spacing. The plain wire-cut brick had done their own spacing. With the extreme regularity that was expected with repressed brick the lugs were deemed necessary. The fact that cement grout filler had come into use did not have a great deal of influence as far as lugs were concerned until engineers began to use the coarse grades of sand in the grout. It is also true the rounded edge of repressed brick assisted the entrance of sand cushion into the joints. Cement grout filler was used with the plain wire-cut brick without difficulty.

In 1910 there was developed the wire-cut brick 3x4x8½ in., having two instead of four ends formed by the die instead of being repressed. The edges were square, whereas wire-cut end brick and vertical fibre brick had lugs. In the first case they have been retained, but in the latter case it was considered by 1917 that lugs were superfluous, and the Association has adopted the 3x4x8½ in. brick without lugs.

In road construction, individual designing has been largely ignored. The same kind of paving and same kind and depth of base being specified for long distances. The time is not far distant when a stretch of pavement will be designed in 100-ft. sections. In a given contract for a single road there may be concrete base, rolled stone, gravel or slag base; and there may be portions requiring no artificial base.

The forthcoming specifications of the Association will recognize the above principles. There will be concrete, rolled stone, gravel and slag bases bound with screenings and with tar. There will be asphalt filler and alternates of sand, cement grout, and combined tar and asphalt fillers. The sand cushion will be specified to accompany bituminous and sand filler the cement-sand bed or the green concrete base where cement grout filler is used.

To sum up the case of brick pavements at the beginning of 1920: 1. The value of thorough sub-soil drainage is becoming realized. 2. The use of a variety of kinds of bases to meet different subsoil, traffic and economic conditions is established. 3. The tendency of design is away from the slab types of brick pavements and towards the types that depend upon the high quality of the individual unit as against the monolithic surface. 4. The use of cement grout filler will be with more discrimination. 5. The coming year will see the widespread adoption of the standard brick in localities now laying numerous varieties of lug brick.

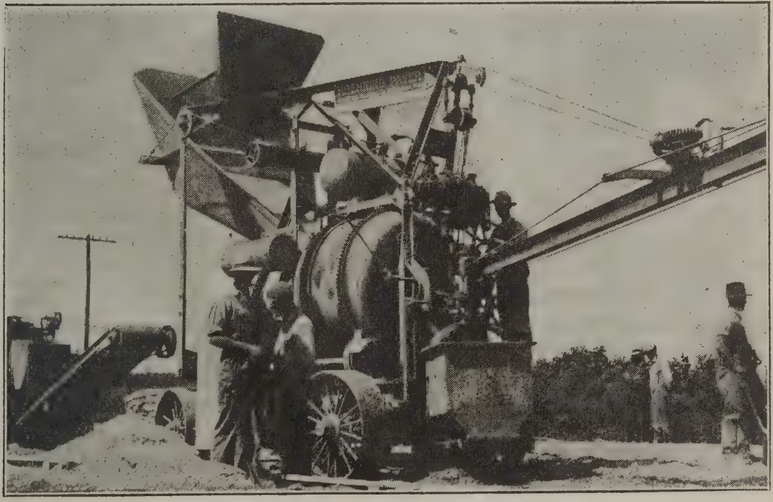
MECHANICAL EQUIPMENT IN HIGHWAY CONSTRUCTION

BY K. H. TALBOT*

With larger amount of money becoming available for highway construction there is coming to be a demand for such construction by miles instead of by feet. The experience in Illinois and throughout the country has shown the average mileage completed per construction unit has been less than three miles per working season. Many contractors have been able to place seven miles of road per season using small equipment, and one with large equipment has placed 14 miles this year. However, these are exceptional performances. Two causes are responsible for the low average. First, the contracts have in the past been awarded late in the season. Second, both contractors and engineers have thought in terms of square yards instead of in terms of miles of completed work.

Laboratory investigations showed that to get a uniform product it was desirable to hold the concrete in the drum of the mixer for at least one minute. Whereas the contractor had previously expected to turn out from 50 to 60 batches per hour, depending on his ability to charge the mixer, he was now cut down to 25 or 30 batches. Studies showed that the usual time required for charging is 10 seconds and for discharging 10 seconds, and therefore, that the number of batches might be increased from 25 to 40 batches per hour if there was no lost time incident to the loading of the mixer.

*Koehring Machine Co., Milwaukee, Wis.



BELT CONVEYOR LOADS CHARGING SKIP

Increased output demanded three things: 1, that the crew be organized; 2, that special loading equipment be used; and 3, that a larger mixer be used in order that the time the material is held in the drum may become a smaller factor in controlling the day's output. Economical organization of the crew is dependent: 1, on the men themselves; 2, on the reduction by time studies of the number of men; and 3, on the replacement of men by machinery.

The first change in machine design looking to more rapid charging of the mixer was the widening of the charging skip to accommodate two wheelbarrows at one time. This proved a great help but still it required wheelers and the output was dependent on the ability to keep the skip loaded. Replacement of men by machinery came with the manufacture of the belt conveyor loader. This consists of a steel frame 60 ft. long, running on traction wheels and operated by a 5-HP gasoline engine. Standardized measuring boxes furnished with bottom dump doors insure proper quantity of aggregate per batch. On this frame an endless belt 22 in. wide travels at the rate of 450 ft. per minute to carry the materials forward and place them in the loading skip. Wheelers are no longer required and the number of men is reduced by six or eight. As soon as the charging skip touches the ground the material is dumped through the hoppers onto the belt and 20 seconds later the skip is ready to be raised.

For some years there has been a tendency toward the use of the industrial railroad for hauling materials in the construction of highways. Among the early methods was the use of cars dumped into a sideloading mixer. But the track was not always at the same relative elevation as the mixer and it was not possible to get full capacity out of the equipment. The batch box system allows the industrial railroad to be operated to full capacity. The mixer is equipped with a derrick so that the box may be swung over the loading skip and there discharged. Consideration should be given: 1, the design; 2, the number of boxes to a car; 3, the use of "V" shaped cars instead of boxes; 4, the use of bottom dump instead of tip-over boxes, and 5, the necessity for quick acting equipment in order that full capacity may be obtained from the mixer.

Road contractors have generally accepted the 2 ft. gage industrial railroad and cars having frames without platforms, placing the batch boxes directly on the frame. For mixers holding 14 and 21 ft. of mixed material the use of two boxes to the car has proved the most satisfactory, but for a mixer of 28-ft. capacity only one batch box should be carried on the car, owing to its weight. The use of V-shaped cars dumping the aggregate directly on the roadbed, to be rehandled by the

mixer loader, has many advantages. It obviates delay due to breakdown at the loading station or on the industrial railway and it allows good storage of material to ensure regular work of the concreting crew. It is probable that a given machine will place more yardage by having material dumped on the subgrade than by handling it in batch boxes. However, the additional cost of rehandling may offset any reduction in cost per yard due to increased output. The batch box system has the advantage of reducing the total number in the crew.

Batch-Box Loads Charging Skip

Three types of batch boxes have been used: 1, tip-over; 2, side dump; 3, bottom dump. The first has a V-shaped body divided into three compartments for cement, sand and stone. Two objections to this are that the cement does not clear rapidly and that in tipping it is difficult to hold the box in place. The side dump box has the advantage of throwing the material well to the front of the loading skip, but has the disadvantage of slow discharge and tendency to kick back. There is no opportunity to separate the cement from the aggregate and unless the bottom slope of the box is considerable the materials will not flow readily. The sloping of the bottom requires a larger box and also places the center of load higher above the rail and to one side. Some boxes are completely inverted so as

to dump from the top. The bottom-dump box with separate cement compartment most satisfactorily fills the requirements both for the 14 and 21 ft. paver, where the boxes are dumped by hand and for the 28 ft. paver where they are dumped by power. With this type of box there is no back kick when the materials are discharged.

Consideration should be given also to the use of motor trucks and also the use of tractors and trailers. Motor trucks are entirely out of their class in heavy mud, while the industrial track must be ballasted in order that trains may run with necessary speed. If motor trucks are used, delays in loading and unloading must be reduced to a minimum as with a rental of even $35 a day. The shortest delays are expensive.

Some contractors have equipped motor trucks with batch boxes while others have divided the body of the truck into compartments and dump direct into the loading skip. Under any but the best conditions, however, the economy of this method is questionable as it is impossible to balance with nicety the hauling schedule of trucks over the newly made sub-grade. With the tractor train, the objection is not so much the inability to operate on schedule as it is the inability to get into position where the derrick on the mixer can easily pick the batch boxes from the wagons.

The method of unloading of materials at the railroad station will largely govern the method of handling the remainder of the job. The unloading may be by: 1, shoveling into wagons, trucks or into movable hoppers; 2, bucket elevators or skip hoists from pits below the track; 3, clam shell bucket operated by a stationary derrick; and 4, bucket operated by a portable crane. The first and second methods have been used very successfully where comparatively small amounts of materials were handled or where the material could be obtained in bottom dump gondola cars, but the fact that labor is expensive and difficult to get makes it desirable to use labor saving devices wherever possible. It is, therefore, recommended that consideration be given to the derrick and the crane. Many contractors have made the mistake of designing their unloading plants with too small storage capacity. For a one-mixer operation it is recommended that a contractor have on hand at least 2,000 tons of stone and 1,000 tons of sand and that he equip with an unloading plant having a capacity of at least 300 cu, yards of material per day.

The expenditure of large sums of money for plant requires that all parts be nicely balanced. Many men have found large equipment expensive and have finished the job with a loss because their plants were not balanced. For instance, they may have had a large unloading plant and a small mixer,

a large mixer and a large unloading plant but poor transportation to the mixer, or insufficient storage at the unloading plant to keep going when deliveries were slow. With a central proportioning plant the use of bulk cement has proved very efficient, the cement being usually shipped in gondola cars with tarpaulin covers, unloaded with the same clam-shell that unloads the aggregate, and placed in overhead bins from which it is measured by volume into the batch boxes.

The demand for mechanical equipment is the outcome of the desire of the contractor to reduce the number of men required to build a mile of road per mixing unit. This has brought to the fore larger mixers in order that the unloading and hauling equipment may be used to its full capacity. With a mixer holding 28 cu. ft. of concrete, equipped with a boom and bucket and charged with a crane, from 100 to 125 ft. of 16 ft. road per hour has been built in Michigan.

To guarantee standardized concrete two automatic features have been incorporated into the mixer: 1, an automatic water measuring tank; 2, the batch meter. The latter controls the time that the batch remains in the drum of the mixer, locking the discharge chute when the material enters the drum and releasing it at the expiration of the time specified. Announcement of the fact is made by the ringing of the bell. Reference has been made to the desirability of the use of machinery as a pace-maker for the crew. One contractor found this year that he was making time and getting out yardage by organizing his crew around the batch meter. The basis of all efficient engineering is time study and timing of operations, and the batch meter offers the contractor a time control for his forces.

SEWER SYSTEM AND SEWAGE TREATMENT AT THE FORT SHERIDAN HOSPITAL

BY H. R. ABBOTT

At the Fort Sheridan Hospital, No. 28, built by the Construction Division of the U. S. Army, the writer's recommendation was for a complete treatment plant, with discharge into Lake Michigan. Plans were prepared in the sanitation section of the Division, in Washington. The site is on the shore of Lake Michigan, 28 miles north of Chicago, and is traversed by numerous large ravines. The tract of 728 acres was acquired by the Government in 1890 for use as an army post.

The post had the separate system of sewers; the storm sewers discharging into the ravines, thence into the lake, while the sewage was discharged into the lake through a sub-

merged cast iron pipe extending 600 ft. from the shore. In 1912 a disposal plant was built, consisting of a hydrolitic tank, trickling filter, secondary settling tank and sludge drying beds. With the conversion of the old post into a general hospital, having a capacity of 4800 beds and a total estimated population of 700, it was decided to amplify the old collecting system and build a new pumping station and disposal plant. About 2½ miles of sanitary sewers were built, ranging in size from 6 in. to 12 in., and 1½ inches of storm sewers, 8 to 24-in. The sanitary sewers lead to a collecting manhole from which the sewage flows by gravity to an inverted siphon crossing the ravine and discharging into the screen chamber of the pump house. This siphon has a total length of 300 ft. and a dip of 35 ft.; the portion with the descending flow being 12 in. and that with the ascending flow being 8 in. diameter. This siphon was laid with Universal jointed pipe. To prevent slips of the pipe, concrete piers were built at the foot of each slope, and a 6-in. blow off was installed at the lowest point of the siphon.

Concrete grease traps with a capacity of 0.66 gallon per capita were built adjacent to the kitchens. These are skimmed weekly and grease recovery ranges from 10 to 25 lbs. per capita per year with an average of between 12 and 14 lbs. At the new pumping station the sewage passes through removable bar screens, set on an angle of 45° from the horizontal. The bars are ¼x1½-in., placed ¾-in. apart in the clear and two screens are set abreast with an extra screen for emergency use. On account of the excessive quantity of rags, surgical dressings and other refuse incident to hospital sewage, these screens have to be cleaned about once each hour during the day and about every two hours at night. The screenings are removed with a hay pitchfork, with tines bent to suit, and dumped through a scuttle into a galvanized iron can, being then burned in the hospital incinerator.

The pump pit has a capacity of 10,000 gals. In order to prevent the excessive formation of scum and to prevent septic action in the pit, the suction pipes are dropped below the floor level. Once a week all pumps are started up simultaneously and the pit is completely emptied, the attendant hosing down meanwhile and passing the scum and sludge up through the pumps, thence to the disposal plant. The pumps handle this without clogging.

Three pumps with a 5 in. suction and 4 in. discharge are installed, each with a capacity of 700 gallons per minute. They are direct connected to 20 h. p. motors. The pumps discharge against a static head of 43 feet and into a 12 in. cast iron force main leading to the treatment works 2400 ft. distant.

New Treatment Works: These consist of a diversion box, septic tank, dosing chamber, trickling filter, chlorinating and humus chamber, secondary settling tanks and sludge drying beds. The septic tank is the standard "Construction Division type, one story, multiple-compartment, horizontal flow, provded with baffles and cross walls, or weirs, to facilitate sedimentation and the withdrawal of the sludge. The entire structure is 43 x 90 ft. and is covered with a wooden house. A dividing wall separates the tank into two units, each having four compartments. Pyramidal bottoms, sloping 40° from the horizontal to a 3 x 3-ft. sump, are provided for each compartment. The sludge draw-off pipes terminate in this sump. A 4-in. water pipe line connects the sludge pipe lines at the tank with the hospital supply system for flushing the sludge pipes after sludge is drawn, hosing down scum and agitating the sludge in the bottom of the hoppers for short periods by applying pressure through the sludge pipes.

The total capacity of the tank, including the sludge hoppers is 290,000 gals. and the capacity of the hoppers only 66,000 gals.; this is equivalent to a per capita capacity of 41 gals. gross and for the hoppers only, 9 gals. based on a 7,000 population. The estimated flow of sewage in designing the plant was for 4,800 patients at 150 gals. and 2,200 others at 100 gals, with an average of 134 gals. On this basis the tank would have an average detention period of about six hours. However, this maximum estimated population was never reached by 25% and the detention period was increased a corresponding amount, as the actual water consumption was very close to that estimated.

Sewage was turned into the tank March 27, 1919. No septic action or gasification could be observed until July 16, although the tank had been seeded with ripened sludge from the old plant. This delay was probably due, in part at least, to the large quantity of disinfectants discharged into the sewer.

The tank is designed on the simplest possible lines, in order to facilitate construction and reduce the cost to a minimum. On account of the shallow depth, the time required for construction, as well as the cost, is a great deal less than that required for Imhoff tanks. Another feature is the maximum effect in sedimentation, thus offering protection to the filter where an excessive quantity of grease is carried in the sewage.

The effluent from both units of the tank flow to a trough 24 in. wide and 10 ft. long, from which the discharge is over a sheet iron weir and into a siphon chamber. The trough is housed in and has a 3-16-in. triangular mesh screen as a protection to the filter. One cleaning per day is sufficient for this

screen. A Sanborn 24 hour clock, water level recording gage is placed in this gallery. A flow diagram was worked out and chart posted for the use of the attendant. This apparatus is also an excellent check on the pumping operations at the sewage pumping station, or by-passing of this raw sewage into the lake at that point would be indicated on the recording chart.

The siphon chamber is pyramidal, 12 x 12 ft. at the top and 4 x 4 ft. at the bottom, equipped with a Miller 6-in. automatic siphon having a maximum head on the sprinkler nozzles of 7 ft. The capacity of the chamber is 2300 gals. and at the average flow of 700 g. p. m. the filter is dosed every 3⅓ minutes. When the filter was first started up it was found that air was being carried into the drum of the siphon by the action of the liquid spilling over the weir and falling near the bottom of the drum. As this prevented the proper operation of the filter, wooden baffles were placed across the chamber at the bottom of the drum, concrete flared away at the sides of the weir opening and certain adjustments made on the siphon vent tubes.

The trickling filter is 106 x 205 ft. or ½ acre in area, with 5 ft. of Illinois limestone, the specifications calling for sizes ranging from 1 to 3-in. Trouble was experienced in obtaining clean stone and a considerable quantity had a large percent of screenings and stone dust. This dust gradually worked down to the gutters, after the filter was put in operation, and finally found its way to ths humus chamber. This necessitated frequent opening of the blow-off valve in this chamber, during a period of about 2 months, after which the dust finally disappeared. The stone is deposited on an undulating concrete floor, the lateral distributing pipes being placed at the summits and the gutters in the depressions.

The spray nozzles have a spacing of 11½ ft. They are on an inclined plane approximating the hydraulic grade line at the average rate of discharge and the distributing pipes and under drains are parallel to this plane. Wherever possible, concrete retaining walls were omitted, terminating the filtering material with steep slopes. The underdrains are 10 in. diameter, the invert being an integral part of the concrete floor, and over this is placed 10-in. split tile supported by broken pieces of tile, leaving a clear opening of ¾-in. between the tile and the filter floor.

The effluent from the trickling filter flows to a covered chlorinating chamber, 13 x 17 ft, having a capacity of 8600 gals. above the hopper. A Wallace & Tiernan manual control, dry feed apparatus doses effluent at the rate of 2½ parts per million.

The effluent from the chlorinating chamber flows through a 15-in. running trap to two 18-ft. circular settling tanks with conical bottoms. The combined capacity of these tanks and the chlorinating chamber is 40,000 gals., affording a detention period of about one hour at the average flow. Effluent passes to a collecting manhole, thence to a 10-in. discharge pipe extending down the bluff and out into the lake about 200 feet, resting on piles. Sludge draw-off pipes lead from the bottoms of the tanks and connect with the same outlet.

Sludge drying beds, 40 x 100 ft. were built, the bed being divided into four equal pockets. Concrete walls enclose the beds and form the dividing walls. The area per capita is 0.6 sq. ft. The filtering material consists of 10 in. of coarse rock, 5 in. of gravel and 3 in. of coarse sand, making a total of 18 in. The beds are under drained with 6-in. vitrified tile laid with open joints and the liquid drains to the chlorinating chamber.

Daily tests with the Imhoff glasses showed a removal of settleable solids of 95 to 99% with an average of about 98%. Relative stability of the filter effluent ranged from 80 to 99%. on tests made in accordance with standard methods of water analysis. The plant was constructed by the Sumner Sollitt Co. The design is by Major L. S. Doten, sanitary engineer of the Construction Division. Work was carried out under the direction of the writer as supervising engineer. Appended are extracts from the general operating rules.

RULES FOR OPERATION OF SEWAGE TREATMENT PLANTS

1. The attendant should carefully inspect all parts of the plant at least once each day.

2. He should at once report to officer in charge any unusual condition or imperfect functioning.

3. The screens or racks of screening chambers should be raked at least once each day or more often if necessary to keep them in good condition and to prevent the backing up of sewage in outfall sewer. Screenings should be removed from platform immediately after completion of raking and disposed of either by burial or by incineration. As soon as screenings are deposited in trenches, they should be covered with at least 3 inches of earth or should be sprayed during warm weather with a 10% borax solution in order to prevent the breeding of flies.

Where detritus chambers have been provided, great care should be exercised to keep them free of heavy deposits. It is essential that they should be thoroughly cleaned at least once each week. Where such chambers are provided with a blowoff, the detritus should be drawn off daily. This operation will obviate any danger of clogging of blow-off line. The material removed from detritus chambers shall be disposed of by burial as required for screenings.

4. In sewage tanks it is desirable to maintain an equal rate of flow through all tanks in service. To accomplish this, in certain cases it may be necessary to adjust the valves on inlet pipe lines or gates in

distribution chambers. A uniform depth of flow over the effluent weirs of all tanks in service is an indication of proper distribution of flow in the several tanks.

5. Where two or more tanks are provided, the operator shall use at one time only such number of tanks as will provide an average detention period of not less than 6 hours nor more than 12 hours. In computing the detention period the entire capacity of each tank shall be used.

6. If the number of tanks is in excess of requirements, as described in (5), tanks should be operated in rotation, a period of two weeks use to be followed by as long a rest period as conditions allow.

7. To produce the best results, care must be taken that all parts of the tank, including all baffles and other concrete surfaces, be kept clean, by hosing and use of squeegee.

8. During the first few months of operation it is essential to break up the scum daily by means of a hose stream or by aid of some mechanical device in order to avoid the formation of a heavy scum, as soon as bacterial action has become vigorous. When the bacterial development in the tank, especially the first compartment, has reached a certain stage, hosing is required less frequently. Scum formation varies considerably in different tanks, being dependent on certain characteristics of the sewage.

9. Wherever the litmus test shows an acid reaction in the raw sewage, milk of lime should be added in quantity sufficient to neutralize this acidity. The quantity of lime required will vary from 100℔ to 500℔ per million gallons, depending upon the degree of acidity of the sewage.

10. At times it may become necessary to transfer partially digested sludge from the first compartment of a tank to succeeding compartments, in order to facilitate digestion. This is especially important where tanks are being used to their maximum capacity. The transfer may be accomplished either by means of a gasoline operated diaphragm pump, or by drawing down the liquid in the last compartments through the draw-down valves and then transferring sludge through the sludge lines. Where sludge pipe system is provided with a direct connection with a water distributing system it is desirable to agitate the sludge in the bottom of the first two compartments by the introduction of water through the sludge lines. This should be done in five minutes periods, weekly.

11. Sludge should be drawn only when thoroughly digested. Sludge in the last compartment should be removed frequently in order to obtain an effluent low in turbidity. Sludge shall be drawn into sludge beds to a depth of not more than twelve inches, after which sludge lines shall be drained or filled with water or clarified sewage, to avoid formation of heavy deposits. Digested sludge should dry to a spadeable condition in three to six days, according to weather conditions. When sufficiently dried, the sludge should be removed from the beds and deposited in fills or disposed of as fertilizer.

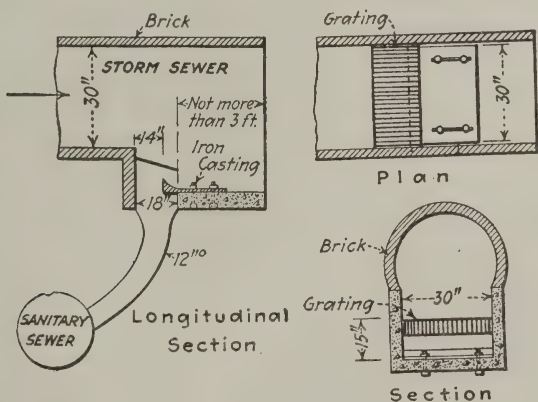
12. Very little difficulty should be experienced with the functioning of the siphon chamber. The walls of the chamber should be kept clean by squeegeing or hosing, and fine screens located in the channel leading to the siphon chamber should be inspected daily.

13. Great care should be taken to keep all parts of the sprinkling filter clean and free from debris. The effluent channel should be cleaned weekly, and the underdrains flushed out when necessary to remove visible deposits. All nozzles should be inspected daily and cleaned where necessary, and broken or bent spindles replaced.

STORM SEWER REPAIRS IN DANVILLE, ILL.

BY H. E. BABBITT

A 3-ft. brick storm sewer under North St. received the surface wash from the streets through untrapped street inlets, the sewage from a few residences, and the manufacturing wastes from a brewery, a creamery and an ice factory. The ice factory's hot water waste with the creamery's sour milk and the brewery's bad brews cooked up an odor that escaped from the inlets with an asphyxiating stench. The method pursued to overcome the difficulty was to trap the inlets with standard 12-in. vitrified traps, placed from two to three feet below the ground. They are now undergoing their first winter. So far no difficulty has been encountered from clogging or freezing and the escape of the stench has been stopped. The installation of these traps cost about $25 each, dependent on the character of the pavement that had to be cut. On some corners as many as eight traps, costing $200, had to be installed. It was feared that trapping the inlets in this fashion would only serve to drive the stench to a point of escape through the many but unknown connections to the storm sewer, but no trouble has arisen so far.



(Cut reproduced from "Engineering News-Record")

The sewer discharges into Stony Creek, a small stream which goes dry in the summer. The discharge of creamery and brewery wastes into stagnant pools so concentrated the fearful stench that residences nearby were rendered almost untenable. Little trouble and no complaint occurred so long as there was some flow in Stony Creek, as even a slight flow was sufficient to cool the mixture and to keep down the odors. The problem was to care for the dry weather flow from the storm sewer, as the storm flow could be discharged with impunity into the creek.

It was found that the trunk sanitary sewer flowed under the mouth of the troublesome storm sewer. A hole was punched in the bottom of the storm sewer for a connection to let the dry weather flow drop into the sanitary sewer, and the bottom of the storm sewer was so cut away that a leaping weir could be installed. This was so proportioned as to discharge all flows less than 30 gals. per minute into the sanitary sewer, and all flows above this into Stony Creek. The leaping weir was proportioned in accordance with a formula derived as the result of a series of experiments made by the author on a number of leaping weirs in the hydraulic laboratory at the University of Illinois.

The grid or screen over the opening has caused some trouble. At first it was placed at so steep a downward angle that it kept itself clean but sufficient of the dry weather flow trickled along the bars and escaped into Stony Creek to renew the uisance during the hottest weather. The angle of the slope was then made flatter so that now there is no trouble from trickling but the screen clogs badly with leaves. The difficulties would probably be overcome by placing the grid at its original slope and cutting the angle so that the trickle would drop back into the sanitary sewer. The leaping weir was first put into operation on a hot dry day in August. Within 30 hours the bed of Stony Creek was dry around the mouth of the sewer and the stench had disappeared. The installations were made by the city sewer department and under the direction of H. H. Edwards, the city engineer.

SEWERAGE AND SEWAGE DISPOSAL

BY M. C. SJOBLOM

Sewerage is considered a necessity in the larger cities and has come to be considered desirable if not absolutely necessary in the smaller cities and villages. Privies, cesspools and septic tanks scattered throughout the communities without sewerage have proved to be not only objectionable but also dangerous as breeders of disease. The rule might well be adopted that a village should install a complete sewerage system as soon as possible following the installation of a public water supply and only under very unusual conditions should a village be permitted to reach a population of 1,000 without having a sewerage system.

Illinois data relative to sewerage installation shows the following: Of 416 towns below 500 population, none have sewers; of 87 from 500 to 600, two have sewers; four of 69 towns of 600 to 700; two of 53 towns of 700 to 800; one of 29 towns of 800 to 900, and three of 37 towns of 900 to 1000.

Thus only 12 out of 691 towns below 1000 population have sewers. Among cities with a population over 1000 there are 189 which have sewerage systems. Of these there are 87 which have a population of 4,000 or over, so that there are only 102 cities between 1,000 and 4,000 which have sewerage. There are 160 places with populations of over 1,000 which are without sewers. A detailed study would doubtless show a large number of the towns to be sewered but partially and many others to have systems which are not worthy of the names of sewerage systems.

Illinois offers innumerable instances of sewerage systems which have not been properly designed. Too frequently the engineer in charge has not taken into consideration the fact that the sewage will eventually have to be carried to one or at most a few points to be treated and has simply designed the sewers to carry away the wastes from the smaller section or sections of the community where it was first demanded. Section after section of sewers are built under no comprehensive plan. Finally when the community has grown sufficiently to demand treatment of the sewage it is found necessary to install a number of treatment plants or to pump the sewage, which at best is expensive if feasible, or it may be necessary to design and install a new sewerage system.

Sanitary engineers, in order to perform the greatest service for their clients and to merit the lasting confidence of the communities, should insist that a comprehensive study be made in each community where sewerage is contemplated, unless this has already been done, and any plans for a sewerage system even to care for but a small part of the town should take into consideration so far as possible the future needs of the community as a whole. It is poor economy on the part of any community to have an expensive improvement such as sewerage installed without a thorough study having first been made. The engineer should, therefore, not hesitate to call the attention of the proper authorities to the necessity of making a detailed preliminary survey even if by so doing the work will be considered too expensive and thus be abandoned for the time being. Only along the larger streams should sewerage systems be installed without provision for at least treatment by sedimentation. But regardless whether sewage treatment is to be provided at once or not, a thorough study should be made of the local situation and the sewerage system so designed that treatment can later be installed without undue difficulty and expense. Where sewage-treatment plants are installed, whether for sedimentation alone or with secondary treatment, the engineer should emphasize the necessity of systematic supervision. At present the average Illi-

nois treatment plant is neglected shamefully, ranging from neglect to clean septic tanks, which comes very near to being a general rule, to the negligence of entire works to a point where they become worthless. A treatment plant properly cared for and maintained, even if not of the best design, will go far to establish a good reputation for the engineer who designed it, especially among the average laymen while a well-designed plant poorly cared for and neglected is quite apt wrongfully to discredit the engineer. It might be to the advantage of engineers as a whole to provide a working arrangement between the engineer in charge of the work and the community, whereby the engineer will have supervision of the plant at least a year or two following its installation. In this way some person could be trained to care for the plant and at the same time the community would be made to realize the necessity of proper attention and the advantages resulting therefrom.

IMHOFF TANK OPERATION

BY W. G. KIRCHOFFER

My first tanks were installed at Elkhorn, Waupun and Whitewater. All of these had concrete covers. The designs were approved by Dr. Imhoff's agents. Detailed instructions were given to the operators as to drawing off sludge and scum, cleaning sludge beds, etc. Our first troubles were at Waupun, where it was next to impossible to get any sludge through the sludge pipe. Black putrescible liquid would come, but nothing else. In the next few designs I attempted to correct this difficulty by leaving off the concrete cover and making the sludge pipe large in diameter, straight and as short as possible.

However, the difficulty still continued, sludge would accumulate on the surface of the upper chamber, with little or none coming out of the sludge pipe. If the period between attempts at drawing off sludge was several months, the pipe would appear to be clogged. At Waukesha the difficulty was somewhat remedied by skimming the scum every two weeks and pumping the sludge (black liquid) from the lower story each month. The effluent from all of these plants was milky, and would soon become putrescible if allowed to accumulate along the banks of the streams. At the Southern Wisconsin Home for Feeble-Minded, the design was again modified by using a sludge well or chimney which extended from the bottom of the tank to the surface and from which a 10-in. horizontal pipe was laid to the sludge bed.

The city of Ripon has a sewage treatment plant consisting of a coarse horizontal screen located over a small detritus pit and three sand filters of about one acre in total area. The

average daily flow was estimated at 345,000 gallons per day, and is a typical domestic sewage with a small amount of woolen mill waste and creamery waste. The plant had given fairly good results, but it was sought to increase the capacity of the filters by removing a greater percentage of the settleable solids by the construction of a treatment tank. Although the Imhoff tanks previously constructed had not given satisfaction, it was thought that these difficulties could be largely overcome by modifying the construction of details, and this plant was designed along somewhat different lines. To avoid the somewhat complicated construction necessary to reverse the flow periodically, the sewage was delivered to the tank at the middle of one side of the tank by means of a large shallow trough with a narrow slot in the bottom. The flow through the upper chamber was to take place in both directions around the tank and pass from the tank on the opposite side in a similar trough. The tank was provided with two sludge wells, two pipes and one gas vent. This design gave a relatively large surface to the upper chamber with a comparatively small space above the sludge chamber as was common in the earlier designs.

The new Imhoff plant was put in operation in December, 1918, and one attempt to draw off sludge was made before cold weather. This was fairly successful, but of course the sludge was not thoroughly digested. A wooden cover was placed and the tank was allowed to operate without interruption until April, when the cover was removed. It was found that there was sludge and scum on the surface of the upper tank to a depth of 3 ft. or more. Sludge had also risen into the sludge wells and gas vent to an unknown depth. An attempt was made to draw off sludge from the lower chamber but only black liquid came, as in all of the other tanks. In a day or so the gas vent began to foam and run over into the upper story. The operator then attempted to clean the tank and remove the sludge from the surface of the upper story. The filter beds were not taking the effluent, but were clogging badly and when allowed to dry out, a thick leathery deposit was found on the surface of the beds. After 976 wheelbarrows full of sludge had been removed there still remained 12 in. or 18 in. of floating sludge on the surface of the upper chamber and in the gas vent. In the upper part of the lower story the sludge was 16 ft. thick.

In the winter of 1917-18 I built a sewage treatment plant for my winter home in Florida, and did just what was contrary to the very principle which Imhoff laid down, discharging the raw sewage into the lower story of the tank. But this tank gave excellent results; the effluent was clear and readily

absorbed in the underground filter. I then modified the design of the tank at the Southern Wisconsin Home, so as to direct the raw sewage into the lower story or sludge chamber. I placed a crosswall in this chamber so that the flow had to take place upward through the slots into the upper chamber, thence longitudinally through the upper chamber to the outlet. Any settleable solids brought up with the sewage could settle out and slide down into the second compartment of the sludge chamber.

That tank was inspected after being in operation for about three months and the effluent was found to be clear but with a very slight odor. There was no scum on the upper story or in the gas vent. The sludge valve was opened and a small quantity of sludge came freely, which was followed by black water. This plant has continued to give good results. A similar tank has been put in operation for the village of Union Grove.

For the plant at Ripon I closed the slots in the bottom of the inlet trough and cut an opening to allow the raw sewage to enter the gas vent. In three or four days the sludge in the gas vent and over the surface of the upper story began to disappear. The gas vent, although converted into an inlet, still acts as a vent, but more so than under the former method of operation. The filters began to show signs of working more freely and inside of two weeks the sludge at the top of the tank was reduced to a layer three to four inches thick. On opening the sludge valves, large quantities of sludge were discharged on to the beds. This dried quite readily and was not objectionable to handle. The leather like mat on the filters did not form, and they operated better than they ever had on fresh sewage. The plant has continued to operate satisfactorily.

No chemical analyses of the effluent of any of these plants were made, so any conclusions must be based on operating results. These experiences have taught that sludge can be much more readily digested by discharging the raw sewage into the sludge chamber than into the sedimentation chamber, and that foaming of the gas vents is prevented. The Imhoff tank was supposed to separate the solids from the liquids and pass them to the bottom of the tank for digestion. Why not put them there at the start and let the liquid rise and flow out rather than attempt to settle the solids? Many of these solids contain oil and grease which will float more readily than sink. Those that do settle soon become charged with gas and rise again, to the surface where they often remain. Imhoff tank designs may be applicable to the conditions in Germany where there may be only slight amounts of grease and oils present or where the sewage is very stale, but according to my experience

they are not adapted to the conditions in Wisconsin, where the sewage is fresh and contains greasy matters.

MR BARTOW: When in Germany a few years ago I visited Hamburg, where Dr. Dunbar, an American, was in charge of the city health service. He said he felt that the Imhoff tank would not be used after five years. That city had an Imhoff tank in use at one of the sewage treatment plants but it did not work satisfactorily. The Doten tank used in our army is of single story type with an arrangement for the sludge to be carried to three tanks in succession, thus obtaining a more thorough digestion. Then there is the scheme used at Madison and at Great Lakes, and adopted by the U. S. Housing Board, where the sludge is digested in separate chambers. This also has a single story tank, but the sludge is moved to a special tank where it is digested apart from the incoming sewage.

REPORT OF DRAINAGE SECTION

The work of the drainage section during the past year has been largely an investigation into the drainage situation in the valleys of the principal streams of the state where large areas are subject to overflow. This work was done in cooperation with the State Geological Survey Division, which was authorized by the 1919 legislature to make a study of drainage conditions throughout the state. Drainage engineers will be interested in the report of this study. The State Geological Survey Division is also doing a small amount of educational work along drainage lines, explaining the benefits to be derived from protection from overflow, and giving some publicity to the plans for the reclamation of the overflowed lands in the Embarass, Kaskaskia, Little Wabash, and Skillet Fork Rivers, which were prepared in 1910-11 by them in cooperation with the Rivers and Lakes Commission.

During the past year there has been considerable interest manifested in the reclamation of the bottom lands. In the Embarrass valley several districts have been formed or are in the process of organization. The landowners along the Kaskaskia, having succeeded in getting a provision in the drainage law whereby one or more districts in one or more counties may combine for providing a common outlet, have a petition for the straightening of the river channel from Carlyle north to the Fayette-Shelby county line, about 90 miles, following the present channel and benefitting some 78,000 acres. In the Cache River valley several districts are being formed and some existing districts are planning to enlarge their drainage systems. A project is being initiated for

straightening part of the Sangamon River channel and sentiment is being aroused for improving the Little Wabash throughout its length. These movements indicate that the owners of these fertile bottom lands are beginning to realize that they can not afford to let these acres remain idle. This means work for the drainage engineer.

We find that drainage engineers as a class are doing very little to stimulate drainage sentiment in their communities. Most of the drainage propaganda is coming from the county farm bureaus, which realize clearly the value and necessity of adding the waste bottom areas in their counties to those already under cultivation. The drainage enginer is in a position to render a distinct service to his community because he above all others understands how protection from overflow and drainage can be secured, what it will cost, and what are the benefits to be derived therefrom. Consequently he should take advantage of all opportunities for giving publicity to drainage enterprises.

At the Eighth National Drainage Congress, held in St. Louis, November 9-11, 1919, a committee was appointed to report to the next meeting upon the fees of drainage engineers. Two members of this section were appointed to serve upon this committee. We believe that such a movement is very timely, as our own investigation has shown that there are a number of engineers in Illinois doing drainage work who are receiving the same fees for their services that they did five and ten years ago.

We call attention to some of the amendments which were made to the drainage law by the 1919 legislature. Senate Bill No. 153, which was presented to the last meeting of the Society by Mr. Dappert and which was approved by it, was passed and is now Section 73 of the Farm Drainage Act. The main feature of this amendment was the elimination of the former clause which limited the fees of drainage engineers to $5 per day. Now an engineer can legally charge all that he can collect.

Under the old law a district located in more than one county and organized in the court of the county in which the majority of the lands was situated, remained under the jurisdiction of that court regardless of any changes made in the size of the district. However, Section 58 was amended to the effect that, when the addition of new lands to a district causes the majority of the lands to be in another county, the records of the district are automatically turned over to the county clerk of that county and all future proceedings are held in the courts of the new county. The Drainage Section opposed this as an entirely unnecessary and possibly a vicious

piece of legislation. The bill was defeated at first, then reconsidered and passed. Another bill which was passed is now Section 44, and provides that the majority of the land owners in a district may abandon the work or organization at any time before actual construction has begun by the payment of court costs, which do not include engineers' and attorneys' fees.

We find that there are entirely too many districts which are only partly successful due to improper engineering design. When a district does not accomplish its purpose, a very forceful weapon is given to the opponents of drainage which they use with telling effect in preventing adjacent areas from organizing. Hence it is highly important that the engineer responsible for the design of drainage works take every precaution to insure the success of the project. With this thought in mind, your committee wishes to offer the following suggestions:

1. Plan the drainage system so that it will provide adequate drainage to all the land within the district. In some instances engineers, in order to make a small assessment and thereby secure the required number of signatures, do not plan the ditches of sufficient size. The result is that after a short period of disappointment on the part of the land owners they are required to raise another assessment to enlarge their ditches.

2. Make a thorough study of run-off for the area in question to determine the drainage coefficient to use in design formulas. This is one of the factors whose scientific determination distinguishes the drainage enginer from the surveyor.

3. Use care in choosing the proper roughness coefficient, "n," in design formulas. We believe that the value of "n" commonly used is too small. In this connection we call attention to articles on this subject which appeared in the "Engineering News-Record" of March 13 and December 4, 1919.

G. W. PICKLES (Chairman), E. A. ROSSITER, J. A. REEVES, W. P. BUSHNELL, A. L. WEBSTER.

ENGINEERS' ESTIMATES FOR DRAINAGE PROJECTS

BY J. A. REEVES

It is common knowledge that except in the case of dredging contractors there has been no incentive for high class contractors to bid on drainage work as the reward has been insufficient and conditions unattractive. Therefore, a great deal of the tiling has been done by local artists whose principal qualifications have been strong backs. In some counties,

districts have been installed by high class contractors at prices double or triple the prices obtaining elsewhere. But there is no complaining, and the work has gone forward repidly, accurately and to the entire satisfaction of the farmers and probably with more certain profits to the taxpayers than if incompetently constructed. Do not cheapen the character of your work, but make drainage contracting a respected calling, worthy of your best services and sufficiently remunerative that you may be able to employ an inspector continually on the job to the great advantage of all concerned. During the past several years there have been many opportunities to note the fallacy of insufficient estimating, and at the same time, to observe that the land owners are ready and willing to pay the cost necessary to successfully drain their lands.

Contracts have been let for double the original estimates and in many instances the taxpayers have been more vexed at the delay in making supplemental assessments than over the amount of increased cost. It is not well enough known, that if the costs were double what they are today, and the land once reclaimed worth only half of what it is today, land drainage and particularly tile drainage would still be the most profitable form of farm investment.

In discussing the subject we are prone to think of conditions as existing today. But proceedings are often so long drawn out that bids may be called for today on jobs where estimates were made three or four years ago. This delay illustrates some fault in the legal machinery operating for the benefit of drainage. Engineers could not be expected to know that labor and materials would advance by leaps and bounds and certainly no blame can attach to them for the increased costs. Furthermore, who can tell what the conditions will be several years hence. There may be some individuals who sincerely expect, as they have expected for a long time, that reductions in prices would occur, but on what they can reasonably base such a conclusion is beyond the writer's conception.

Drainage contractors are confronted with another condition not heretofore considered serious. Several years ago it was fairly easy to secure men for country work where drainage work is invariably located, but today there seems to be an aversion to working away from the cities, and contractors are not only compelled to pay a premium for such labor but in addition are required to provide conveyances for taking the men daily to the nearby village or town, that they may have amusement.

Engineers should take into consideration the certainty of freight advances which then is reflected in the increased cost of all materials. The coal question is still unsettled but there

are many who predict further advances very shortly. Aside from anticipating the above items of added costs, engineers would eliminate much of the speculation of drainage contracting if a more careful survey of conditions was afforded to contractors. It is not desirable that a contractor should make an unfair profit, nor lose his capital in this work. Engineers would do well to request information from responsible contractors as to probable costs before considering their estimates complete. So long as there is no better means of awarding contracts than by competitive bidding, and the benefits to the taxpayers resulting from the work justify greatly increased expenditure, there is no excuse for insufficient estimating. For these reasons there should be close cooperaiton betwen engineers, contractors and material manufacturers.

G. W. PICKELS: We cannot lay too much stress on engineering estimates. Farmers are willing to pay the cost of a good system if they understand it. I find that many farmers do not understand just what we are trying to do. When the matter is explained they are usually willing to play their part.

MR. ROSSITER: The Westmoreland drainage district was the highest priced district organized in Cook County, the average cost being $35 per acre. The highest assessment was $65 per acre, and the $65 man kicked because it was not done fast enough. As to the estimate, we were working on a contingent and percentage basis. The commissioners were afraid the engineer was going to overload his estimates. In order to be fair I asked a number of contractors to submit preliminary figures, among them Mr. Reeves. My estimate on 24-in. tile, 12 ft. cut, was $3.60 per running foot. Mr. Reeves' subcontractor claimed he could do the work for $2 per foot. When the work was awarded at that price the contractor lost over $15,000 but he did the work satisfactorily.

MR. C. S. GANNON: In the Levee & Drainage Contractors' Association, of St. Louis, we find this a pretty difficult matter. The work extends over two or three years usually. It is hard to get manufacturers to say what costs are going to be. About the only thing that can be done is to take present-day prices and add a little to them. If we can help anyone in figuring costs we shall be glad to do so.

W. D. GERBER: Drainage is more than removing surplus water from land. It is the improvement of land to a point where plant food can be drawn into the soil to produce additional crops. If soil is not fit for farming it is not fit for drainage. I often wonder if engineers present these facts to the farmer in a convincing and interesting manner.

G. W. PICKELS: The county farm advisors are doing a great deal to interest and educate farmers on these very points, and at meetings they bring out the necessity of crops having the proper amounts of air, heat and moisture, which can be gained only in a soil properly drained. It is not only land covered with water that needs drainage. It needs drainage if water stands within 3 ft. of the surface. There are two distinct problems: to keep flood water off the land and to drain land subject to overflow.

DRAINAGE IN ILLINOIS

BY E. A. ROSSITER

The writer has spent some time in his efforts to better conditions and make it easier to organize and maintain drainage districts in this state. With that end in view he had introduced in the legislature of Illinois a number of amendments in which the bars would be let down so that we might put over some big drainage system. In the drainage committee he met the most courteous treatment each year, but the relief sought was always defeated. At last he spoke to one of the down-state floor leaders and stated that for some reason or other the farm lands in the central part of the state were worth $350 to $550 per acre, while farm lands within 25 miles of Chicago could be purchased for $75 to $125 per acre, all because of lack of drainage; that Cook County needed and wanted drainage and that we wanted it made easier to organize a drainage district. Whereupon it was replied that the down-state men were against drainage.

During the last session another amendment was presented and an attempt made to eliminate the non-resident owner in the consideration of acreage or number of owners. We then tried to reduce the number of acres or owners represented on a petition, both of which were lost. At this juncture I conceived the idea of taking several members to dinner and having a heart to heart talk with them. From each of them I learned that the majority of the down state members were active or honorary members of gun clubs and that drainage would ruin the season's pleasure.

This last year in our legislature, instead of advancing the cause of drainage an amendment was passed by which a majority of owners could abandon a district by filing a petition and paying the court costs, which cost is $10. It was a crime to enact such a law after the engineer had spent several thousands of dollars to make his surveys, plans and the lawyer had spent his time, to then have our legislature say all this is lost.

It has been suggested that the Department of Public Works take over the drainage matter and handle it on the same plan as it does the State highway and bridges. In answer to that I raise the following objection: Our state institutions are turning out engineers each year and if you place all the engineering in the hands of the State you can soon give up your colleges or engineering as you will put the engineer in private practice entirely out of business.

DECATUR AND JACKSONVILLE DAMS

BY S. A. GREELEY

Jacksonville Dam. Originally, a small impounding reservoir supplied the town, supplemented shortly after by another small reservoir formed by a low dam across the stream from which the future supply is to be drawn. Wells in the Illinois River bottom lands did not prove a success and finally some drift wells were sunk north of the town. The quantity is inadequate and the quality unsatisfactory. The city population is about 16,000 and there are several public institutions which bring the total population up to about 19,000. The city is fully metered and has an average daily consumption of about 1,250,000 gallons. The maximum demands are modified by a storage reservoir holding a day's supply and located high enough to provide a gravity supply.

Upon investigation, several possible sources of supply were apparent; but it was finally recommended that a new impounding reservoir be formed by constructing a dam across the south fork of the Mauvaiseterre creek adjacent to the old pumping station. The total tributary area is about 27 sq. mi., 2½ sq. mi. of which supplies a small reservoir incorporated in a park. This new reservoir will have a maximum depth of 14 ft. to the spillway, flood approximately 240 acres with water at the crest elevation, and contain about 430,000,000 gallons. The available draft will average 1,500,000 gallons per day and 2,000,000 gallons per day in all but the driest years. The city voted a bond issue to finance the project in accordance with the recommendations.

The length along the crest of the earth section of the dam is about 600 ft. and the height is 22 ft. The spillway is 160 ft. long and is set 8 ft. below the top of the earth embankment. Provision for a flood flow of 4500 sec. ft. with a 4-ft. flow over the spillway is made, which is equivalent to 167 sec. ft. per sq. mi. The spillway is practically a submerged weir with discharge into a sloping channel. The channel is narrowed to 65 ft. wide at the lower end, thereby using up a portion of the velocity head, and is lined with 6-in. of concrete on gravel to

prevent erosion from the high velocities. Bids were taken in April, 1919, and a contract for $58,887 awarded to John T. Walbridge Engineering & Contracting Co., of Chicago.

The material in the dam is compacted clay taken from excavation in the side hill for the spillway channel. A concrete conduit and gate house are located near the center of the earth embankment. The conduit was used to take care of the ordinary stream flow during construction and is to carry the pipe lines to the pumping station. The total cost was $54,100 or $12,560 per million gallons of storage capacity. The itemized costs are as follows:

Earth fill, 28,453 cu. yd. at 50 cts	$14,226.50
Stripping, 3104 sq. yd. at 60 cts	1,862.52
Excess spillway excavation, 3517 cu. yd.	1,406.80
Core wall, 1666 cu. yd. at $2	3,331.80
Conduit and gate house	9,300.00
Slope paving 4000 sq. yd. at $2.50	
Slope paving 1123 sq. yd. at $2.00	7,754.00
Spillway, $21,000 less 5313 cu. yd. at $9	16,218.30

Decatur Dam. In Decatur, Ill., the need for additional water supply has been recognized for the last 8 or 10 years. The extreme dry weather flow of the Sangamon River there is almost nothing, and the problem was to remedy this condition by the construction of a storage reservoir. Preliminary investigations and action by the city council had settled the location of the proposed dam. The storage required, the type of dam and spillway capacity were items requiring extensive study. The maximum flood on record in the river at Decatur occurred in 1913 and was approximately 21,500 sec. ft., equivalent to 25 sec. ft. per sq. mi. from the tributary area of 862 sq. mi. Assuming a 5 ft. depth overflow, a spillway 500 ft. long would be required. The earth embankments will be 13 ft. above the crest, so that the spillway will safely pass a considerably greater flood.

The amount of storage required was determined from local conditions, which made it feasible to provide a total storage of about 9 billion gallons, yielding an average daily flow of about 40 million gallons. A concrete gravity section was adopted for the spillway. Borings indicated a reddish brown clay for the first 10 ft., with alternating layers of gravel and sand for 10 to 40 ft. Below this is an 8 ft. layer of clay, and below this, more sand.

The dam is designed to reduce the velocity of percolation and thereby prevent undermining by the provision of a sufficient length for the enforced percolation. This is accomplished by means of steel sheet piling, a broad base, and upstream and downstream aprons. Under the spillway section,

round bearing piles spaced 3.25 ft. c. to c. are used. The crest of the spillway is 500 ft. long and 28.5 ft. high, while an additional 2 ft. of storage may be obtained by a movable crest. The foundations are also designed to stand an increase of 5 ft. in the height of the spillway. Two 9 ft. x 14 ft. flood gates. and a 4 ft. x 4 ft. flushing gate are incorporated in one end of the spillway. There are also two 36 in. water pipe connections, one of which is reserved for future use.

The earth embankments are 13 ft. above the crest, and are 1200 ft. long, being cut approximately in two by the concrete section. The effect of the reservoir formed by this dam will be noticeable 12 or 15 miles upstream. The cost of the entire project is estimated at $1,250,000 including land.

THE ILLINOIS WATERWAY

BY M. G. BARNES

Chief Engineer, State Division of Waterways

Since the early 80's waterway advocates have been trying to secure the adoption of some project for connecting Chicago with the inland system of the Mississippi. In 1908 the Illinois constitution was amended to permit the expenditure of $20,000,000 for a waterway connecting the end of the Chicago drainage canal, at Lockport, with the improved channel of the Illinois River at or near Utica, a distance of about 65 miles. One of the first of the many projects called for dimensions which would accommodate vessels up to 24 ft. draft. At about that time Congress appointed a Board from the United States Engineer Corps, together with one engineer from civil life, to make a complete study of the Great Lakes and Gulf waterway project. This Board opposed a channel designed for ocean and lake shipping, and also opposed the 14-ft. project that had been proposed as the first step in the carrying out of the 24-ft. project. A board of engineers appointed by Governor Dunne, advocated a waterway with locks 45 ft. in width and 250 ft. in length. A bill was passed and the state legislature appropriated $5,000,000 for construction.

The route followed the Illinois river up to the junction of the Kankakee and Des Plaines rivers; and the Board recommended that the old Illinois and Michigan canal should be used to Lockport, at least temporarily. For the improvement in the Illinois river, it was necessary to apply to the Secretary of War for a permit, which was refused. When Gov. Lowden began his administration he was confronted with an amendment of the constitution permitting the expenditure of $20,000,000 for a waterway and with the law of 1915 calling for

the construction of a waterway which did not meet the approval of the U. S. Government.

At this juncture the writer was called in to make yet another investigation, to advise as to the proper design of a waterway and to estimate its cost. As none of the earlier projects seemed to meet the situation, he ventured still another plan which it was believed would meet the approval of the Federal authorities. It was his belief that greater advantages would accrue from the use of a barge canal or waterway, even though it might be necessary to unload from the barge to ship at New Orleans and Chicago. The cost of transportation would be less than if carried in ocean vessels and there is the added advantage that barges of small draft and tonnage could be delivered to individual shippers and also could float on waters other than the main channel between Chicago and New Orleans.

To improve such shallow waters as the Mississippi river above St. Louis, the Missouri, Ohio and Red rivers, and many other branches of the Mississippi, to any depth greatly in excess of what nature provided, would be expensive in first cost and entail enormous annual charges for maintenance and operation. Their unusual width and relatively low velocities appeared to the writer to lend themselves peculiarly to the floating of shallow craft, many of them lashed together in large fleets. With this in mind he planned a waterway that should meet the natural conditions without excess in cost, and at the same time, would permit of greatest use of the waters and at a minimum of transportation costs.

To this end locks were provided 110 ft. in width and 600 ft. in usable length, with miter sills 14 ft. below extreme low water. As the Illinois river below Utica is less than 8 ft. in depth and the Mississippi river above St. Louis, only 6 ft. in depth and the Ohio being improved to a 9-ft. depth, it was believed to be unwise at this time, to excavate the connecting channels between the locks to a greater depth than 8 ft. in earth and 10 ft. in rock. However, structures were designated for a 14-ft. waterway in case that should ever be found advisable. The writer has laid out this work as to permit of the greatest possible development of both navigation and power.

After this report was placed in the hands of Gov. Lowden, and upon his recommendation, the legislature of 1919 passed a new waterway act calling for locks 110 x 60 ft., with 14 ft. of water over miter sills and having connecting pools 8 ft. in depth in earth and 10 ft. in rock, the channel having a bottom width of at least 150 ft. This waterway act repealed the act of 1915.

Since the bill became a law the Department of Public Works and Buildings has organized an engineering force employed on the design of the various structures. Application has been made to the War Department for a permit to construct the waterway. The plans have met the approval of the Federal engineers and the people of Illinois have voted $20,000,000 to defray the cost of its construction. It appears, therefore, that this very important waterway has passed practically all of the hurdles placed in its way. With the construction completed, Illinois will have a waterway capable of transporting fleets of 7,500 tons each without breaking up fleets at the locks.

DISCUSSION

MR. PICKELS: It appears to me that the State is going to expend a good deal of money for benefits that are rather doubtful. Ths history of inland navigation has not been very optimistic in this country. We find that our canals have not paid interest on the cost. As to the Illinois waterway, if we get it built, we will have to provide commodities to be hauled over it. It is true that this is the center of a great producing area, but we have to get material and crops to shipping points and to provide facilities for loading them on ships.

MR. DEWOLF: Among the possible sources of traffic are the mineral resources tapped by the Illinois river. A canal from the Big Muddy river to the Mississippi, with a dam near Murphysboro, was recommended a few years ago by the Rivers and Lakes Commission to open up the southern Illinois coal fields. Then there is the gravel and limestone along the Illinois river, and I am hopeful that the Illinois valley will furnish a big volume of traffic for movement on modern barges.

MR. ROSSITER: One reason why river traffic has been a failure is the large proportion of the steam barge taken up by engines and fuel, but with oil engines we may see a new development in barges.

MR. DAPPERT: At one time I was rather favorable to spending energy and money in canals, but after finding how little use is made of the Hennepin canal I changed my views.

MR. HERBERT: Experiment with the oil engine has not proved a success. The Inland Navigation Co. had several steel barges running between St. Louis and New Orleans, but the overhead expense was entirely too great for the capacity of the barges and the compensation they got for hauling low commodity freight.

PROF. BAKER: If freight is to move profitably on inland waterways we must take into account such factors as loading

and unloading, terminal facilities and trucking from the river to the factory. It is dangerous to draw parallels between European and American practice because many factories in Europe were built on the rivers before there were railroads, and in this country the location of factories has been with reference almost wholly to the railroads. I hope our members have read the remarkable series of articles on "Inland Waterway Transportation" in the "Engineering News-Record" of Jan. 1 to Jan. 29.

GRAVEL AND LIMESTONE IN ILLINOIS

BY F. W. DEWOLF

Gravel production in Illinois showed a progressive decrease from 4,500,000 tons in 1915 to a little over 1,500,000 tons in 1918. In crushed limestone the decrease was from 4,500,000 tons to 2,800,000 tons, the combined totals showing a decrease from nearly 9,000,000 tons in 1915 to less than 4,500,000 tons in 1918. This is due largely to the limitation of building operations during the war period, to the shortage of railroad cars, and to increase in freight rates, and we may expect that 1919 figures will show some return to normal. But the situation is serious when you pile on top of the normal demands a new requirement for materials with which to build a thousand miles of road a year. Consequently, during this past season, the Geological Survey in cooperation with the Highway Division has been making a special search for new localities where quarries and gravel pits may be opened within easy reach of railroads; and has also considered the possible expansion of existing querries and gravel pits.

In the search for additional limestone sites, the controlling thing is the geology; the next item of importance is proximity to present railroad lines, so that only short spurs might be necessary; and a third factor is the location of the State roads projected for the next two or three years.

Two men were busy last year in the search for limestone localities, but the job will take at least one more season. The work of last year was confined to the southern section. The great central part of the state is underlaid by "coal measures," in which there is a limited development of limestone. True, there is an available limestone varying from 15 ft. to 20 ft. in thickness, well up on the "coal measures" strata, but the more promising limestone beds are in the Missippian formations, which lie immediately under the "coal measures." Still lower there are possibilities in the Devonian, Silurian, and Ordovician strata.

The upper formations which I have called "coal measures" cover three-fourths of the state, overlying the Mississiippian and Devonian systems, but quarry production from these earlier and lower rocks is feasible only where they crop out. So the field work has been largely confined to those marginal counties in which Mississippian and lower formations may be expected at the surface. The work in southern Illinois has been rather disappointing.

It is unfortunate that limestone does not well resist weathering, and does not commonly persist in hill tops, unless these are capped by sandstones. When you look for exposures in the hills which would permit gravity arrangements for a quarry, you nearly always find that the limestone has been eroded from the tops, and that the conspicuous hills are capped with sandstone which could not easily be stripped off. However, we have found a number of promising locations within reach of railroads, and this limestone may be developed and conveyed into the central part of the state where there is little or none.

GRAVEL DEPOSITS OF ILLINOIS

BY MR. LEIGHTON (Illinois State Geological Division)

The last ice sheet of the glacial periods which affected Illinois extended to a curving line that passes through Marengo to Peoria and Shelbyville and then east into Indiana. The front of this sheet remained long enough to build up a broad moraine of considerable height which now serves in many instances as a divide between drainage lines. As the climate ameliorated the ice retreated, building the moraine that passes through Urbana and Champaign and then the moraines that lie successively nearer Lake Michigan.

The distribution of the gravel deposits was determined by the outwash from the front of the ice at its various stages When the ice was along the outermost moraine, the outwash followed the valleys of the Wabash, Embarrass, Kaskaskia, Sangamon and Illinois rivers. These deposits are relatively small. When the front of the ice sheet was along the Champaign moraine, some outwash drained into the headwater forks of the Embarrass valley and some into the Kaskaskia and Sangamon rivers. When it lay along the moraine which passes through Bloomington, there was drainage along the Illinois and the Green river, and the north and south branches of the Kishwaukee, the latter leading to the Rock river. Subsequent positions of the ice sheet as it retreated toward the Lake Michigan basin gave rise to outwash along the Vermilion, Illinois, Fox, DuPage and Desplaines rivers and some of

their tributaries. In the northwestern part of the state the ice moved in such a direction as to obstruct the valleys, as for example the Pecatonica valley, producing bodies of standing water in which silt, rather than sand and gravel, was deposited.

If the deposits had remained as first placed, we would have immense quantities of gravel but the waters from the lake overflowed into the Desplaines river and reached the Gulf om Mavico via the Illinois and the Mississippi. This great overflow carried away large amounts of gravel which had previously been deposited along the Illinois river. One of the remnants is the large elongated hill along the Desplaines valley southwest of Joliet.

Some of the valleys in the southern part of the state are characterized by broad mud flats rather than sand and gravel deposits. These streams are tributary to the Mississippi and during the last glaciation became sites of ponds and shallow lakes in which great amounts of silt were deposited. Thus the southern part of the state is barren of large commercial deposits of sand and gravel, in contrast to the northeastern section. The gravel of the northeastern portion is composed chiefly of limestone pebbles, with some granite and other crystalline varieties which were brought down from Canada. Practically all of the material is firm; the sand is sharp and mostly well graded. The gravel of the old glacial drift, however, has been subjected to the weather for such a great length of time that the pebbles have been softened and consequently are not fit for first-class concrete.

NOTE.

FEDERAL DEPARTMENT OF PUBLIC WORKS

Progress has been made with the campaign for a Department of Public Works as part of the national government, but Congress adjourned without passing the bill. Engineers in general have not given sufficient interest and support, the effective work having been done by a relatively few men. Every engineer who favors this Department is urged to write or see his congressman and senator and inform him of his earnest desire to see the Department of Public Works established, as a step toward greater government efficiency. Engineers in cities can also inform their local chambers of commerce to the same effect. Let the Illinois Society of Engineers be active in this.

S. A. GREELEY
President
of the
ILLINOIS SOCIETY OF ENGINEERS
1921

LIST OF ADVERTISERS

PRESIDENT'S ADDRESS

F. C. LOHMANN, PRESIDENT, 1920

We have assembled for our 36th annual meeting, to transact society business, to discuss engineering subjects that we may broaden our knowledge and improve the profession, and, incidentally, to renew and extend acquaintances. The latter is a very important factor, for after laying aside our regular routine of work for a few days, and discussing problems of mutual interest with fellow members, we shall return to our homes with a new zeal, a renewed interest in our work, and a better understanding of the ideals of the Society.

Your officers decided at the beginning of the year that the most important work before them was to stimulate interest toward the Society among the members, and to develop some method of making the Society of more service to its members. As to the best method of stimulating interest in the Society, it was decided to center our efforts toward securing a larger attendance at the annual meeting. For this purpose, a committee was appointed which assumed the task of carrying on this work. This committee has worked faithfully. They inaugurated the prize paper contest, kept the membership informed by letters on what might be expected at the annual meeting, and cooperated with the secretary in drawing up the annual program.

As an attempt to broaden the activities of the Society and to increase its utility to the members, a service committee was appointed, whose duty it was to supply information on engineering problems to enquiring members or to refer such enquiries to members best qualified to supply the information. Through this method of cooperation, it was attempted to make the Society useful to its members through its members. The value of this committee depends only upon the use of the members of the Society make of the opportunity offered them.

The question of engineering society organizations has been a subject of much discussion among leading engineers. This discussion has grown out of the fact that there is a great need for cooperation among societies for handling questions affecting the profession generally. As a result, an organization known as the Federated Engineering Societies has been formed, and we have been invited to join this organization. On the other hand, the American Association of Engineers has been active in obtaining the affiliation of state societies to avoid duplication of work. We have also received a proposal to affiliate with this organization. These two propositions will be discussed during this meeting, and they both deserve careful consideration. This Society will be called upon soon to decide whether it is to remain an individual organization or whether it is to accept one of the schemes that have been

proposed. These questions should be weighed carefully, and in whatever discussion takes place or whatever action is taken, the best interests of the Illinois Society should be uppermost in our minds.

During the past year, several meetings of the Executive Board have been held, and from the results obtained I believe that we should provide for meetings of the Board to be held periodically to discuss matters of interest to the Society. The expense of these meetings should be defrayed by the Society. With the limited funds available, this is not feasible with the present size of the Board, and I would recommend that its membership be reduced to such a number that meetings can be held at the expense of the Society at least twice a year in addition to the usual meeting which is held just prior to the annual meeting. The advantage to be gained by more frequent meetings of the executive board will be to keep the board active throughout the year in the interest of the Society, thereby contributing to its life and growth.

RESOLUTIONS ADOPTED AT THE 1921 MEETING

1. *Highways.* Investigation of pavement types and design will result in great benefit to the public, and the State Division of Highways is urged to construct experimental sections of pavement of different types in order to study and report on the results.

2. *Drainage.* Proper drainage of farm lands is the first requisite for improvement, preceding lime and fertilizer. Farm advisers are urged to cooperate in the furtherance of this movement.

3. *Water Works.* Legislation is desirable which will enable municipalities to finance waterworks construction to better advantage.

4. *Topographical Map.* As the U. S. Geological Survey has decided to reduce the 35-year program to 13 years for mapping the entire country and has allotted $35,000 per year to Illlinois, the State legislature is urged to accept the 13-year program and to make a similar appropriation of $35,000 per year for work in cooperation with the Federal survey.

5. *Section Corners.* The State Division of Highways is urged to cooperate with county officials in the preservation of existing section corners and the reconstruction of such monuments lost or removed in the construction of highways.

6. *State Board of Health.* The ability of the present director of the State Board of Health in guiding the work successfully through two administrations is commended to Governor Small, with the hope that his services may be retained to the State.

7. *Public Utility Regulation.* The Illinois Society of Engineers approves the principle of regulating public utilities by a State commission.

REPORT OF THE SECRETARY

During 1920 action has been taken on two important questions. By a vote of 9 to 2 the Executive Board approved a schedule of salaries for engineers, as submitted by the Engineering Council, on the ground that although not entirely satisfactory the schedule is a good beginning. By a vote of 11 to 1 the Board decided against joining the Federation of Engineering Societies, for the reason that about $270 a year, or one-fourth of the income, would have to be paid to the Federation for work which

is intended to advance the interests of the profession but would bring no direct returns to the Society or its members. Further, the aims of the Federation are indefinite and the Board did not feel that the Society should undertake to make such a large payment for this purpose and thus cramp its own proper activities.

A competition of papers for five prizes of $25 in five divisions of engineering was a new idea started in 1920, which aroused considerable interest. Five papers were received and two prizes were awarded. The annual volume of "Proceedings" and five Bulletins were issued during the year, but owing to the great increase in cost of printing most of the papers had to be condensed. Exchanges of Proceedings were made with the engineering societies of Connecticut, Iowa, Michigan, Minnesota, Ohio, Kansas and Wisconsin. The Proceedings were sent also to the usual list of libraries.

The Society being an incorporated body, the annual report of election of officers was filed with the County Recorder of Cook County, as required by law, the Society being registered in that county. A summary of the year's business is shown in the accompanying financial statement.

E. E. R. TRATMAN, Secretary and Treasurer.

FINANCIAL STATEMENT, DECEMBER 31, 1920

Bank balance December 31, 1919 (exclusive of savings bank)		$ 397.86
Receipts		
Annual dues	$838.00	
Entrance fees	75.00	
Advertisements	560.00	
Total for 1920		$ 1473.00
Total receipts		$ 1870.86
Expenditures		
Printing and distributing "Proceedings"		$ 610.67
Printing, stationery, etc.		110.87
Printing five Bulletins		71.70
Stamps		64.00
Express and freight		107.96
Typewriting		46.23
Packing and distributing exchanges		15.20
New book shelving		7.20
Stenographer's report, 1920; U. of Ill.		33.00
Convention expenses, 1920, miscellaneous		20.00
Badges		16.75
Programs		17.00
Secretary		250.00
Certificate of election of officers		.55
Subscription to National Drainage Congress		15.00
Committee expenses		8.00
Total expenditures		$1418.77
Total receipts		1870.86
Bank balance, Dec. 31, 1920	$452.09	
Saving account reserve	329.41	
Liberty Bonds	400.00	
Total assets, Dec. 31, 1920		$ 1181.50
Total assets, Dec. 31, 1919		1127.27

PROCEEDINGS OF THE ANNUAL MEETING

The 36th annual meeting was held Jan. 26-28 at the Great Northern Hotel, Chicago.

January 26—At the morning session, after the address by the retiring president, F. C. Lohmann, of Champaign, an interesting address on "Special Assessments and the Local Improvement Law" was given by Edgar B. Tolman of Chicago. It was voted to have a committee appointed to consider amendments to the Local Improvement Law. The president appointed the following: Committee on nominations: G. H. Reiter, J. W. Dappert, W. P. Bushnell; Committee on resolutions: W. D. Gerber, G. E. Warren, J. G. Gabelman.

At the afternoon session the Drainage Section (G. W. Pickels presiding) had three papers: "A Drainage Survey of Illinois," by Mr. Hance, of the State Geological Survey; "Design of Tile Drainage Systems" by J. W. Dappert; and "Economic Accuracy and Cost of Surveys," by Edmund T. Perkins (read by L. K. Sherman.) The Surveying Section followed (Wm. Kramer presiding) with four papers: "Perpetuation of Land Monuments and Markers," P. E. Kollehner; "Preservation of Section Corners Under Pavements," B. H. Suhr; "Land Surveying as a Distinct Profession," Wm. Kramer, and "What is a Permanent Corner" by W. D. Jones. It was voted to have a committee appointed to consider legislation for the perpetuation of section corners. Opinions were expressed in favor of amending the surveyors' licensing law so as to apply to the whole state (instead of Cook county), but no action was taken. The evening session was in charge of the Sewerage Section (S. A. Greeley presiding). Addresses on recent developments in sewage treatment were given by Dr. A. M. Buswell, director of the State Water Survey, and by Langdon Pearse, sanitary engineer of the Sanitary District of Chicago. A paper on the activated sludge plant at Grand Rapids, Mich., was given by the engineer, M. P. Adams.

January 27.—The morning session was in charge of the Road and Pavement Section (H. J. Fixmer presiding.) Several papers were read: "Local Conditions and the Design of Brick Pavements," M. B. Greenough; "Bituminous Pavement Construction," H. M. Skidmore; "Contracts and Specifications," Geo. W. Tillson, consulting engineer; "Alignment and Grades for Modern Roads," R. E. Toms, U. S. Bureau of Public Roads; "Wear and Strength of Concrete," D. A. Abrams; "Concrete Roads," S. T. Morse; "Research in Highway Problems," C. C. Wiley; "Highway Transport Surveys," A. H. Blanchard, University of Michigan. In the afternoon an excursion was made to the Calumet sewage pumping station of the Sanitary Ditsrict of Chicago.

At the evening session, Prof. A. N. Talbot announced the award of prizes in the competition for papers, and the two prize papers were read: "How to Keep Our Pavements Smooth," by Harlan H. Edwards, and "The Future of the Asphalt Pavement," by Allen Dimmick. The report of the Committee on Cooperation, read by Paul Hansen, recommended a ballot vote on a proposition to affiliate with the American Association of Engineers. Other plans were suggested in a prolonged discussion. The outcome was the appointment of a committee to submit to the Executive Board changes in the constitution which will permit of affiliation with any other society.

January 28.—An excursion was made in the morning to the stock yards. At the afternoon session (H. F. Ferguson presiding) the report of the Committee on Water Supply was presented by G. C. Habermeyer and W. D. P. Warren; a paper on "Water Supplies in Small Cities" was read by Wm. Artingstall. The business session was then held, the committee on nominations presenting the following tickets, the ballot votes

being shown by the figures: For president, S. A. Greeley (34), D. A. Abrams (7); for vice president, R. I. Randolph (22), G. C. Habermeyer (18); for trustees, M. L. Enger (23), W. D. P. Warren (23), F A. Windes (19), A. L. Webster (15). The annual dinner was held at the Great Northern Hotel in the evening.

KEEPING OUR STREETS SMOOTH

BY HARLAN H. EDWARDS *(Prize Paper)*

Constant care and intelligent supervision go far in eliminating ordinary defects. Aside from actual wear due to traffic and climatic conditions, and granting that the pavement has been substantially built, the smoothness of city pavements is ruined by three things, any one of which is sufficient to cause a considerable inconvenience to traffic. These are: (1) Uncontrolled cutting through pavements for connections or repairs to underground pipes, (2) improperly built or maintained street railway tracks, and (3) rough railway crossings. These can largely be eliminated by strict supervision, by suitable pavement construction along car tracks, and by the use of a permanent but easily repaired surfacing between the rails at crossings.

In cities where the cutting of holes in pavements is controlled by a good ordinance strictly enforced, very little trouble is encountered from this source. It is a common thing in many of our cities, however, to find streets actually dangerous for travel, due to improperly backfilled trenches and to inadequate repaving over these holes. This condition can be traced to one of two things—little or no regulation, or lax supervision. This was the condition in one of our small but growing cities several years ago. Old street openings were found in many places where the pavement had never been replaced, and where broken concrete had been thrown back in the hole, sand spread over this and a new brick surface laid and grouted. Settlement was bound to take place and a dangerous hole was the result. Fortunately, the city soon afterwards experienced a change in administrative officers. The old superintendent of streets (a druggist) was let go, and the new city engineer was given control of the maintenance and repair of the streets.

Immediately corrective measures were taken. An ordinance was passed making it an offense to make openings or excavations in streets without first taking out a permit and filing a sufficient bond to protect the city against any damage which might be caused by the existence of the hole. It further provided that on all excavations in improved streets the backfill was to be made and the pavement replaced by city forces, charging the property owner the exact cost plus 10 per cent for the work. The ordinances fixed the manner of replacing the pavement slab, requiring that a concrete base slab extend a foot on solid ground on each side of the excavation and that its thickness be one foot. Where a concrete base existed, its edges were sloped as a wedge. If the trench were wide or deep, ½ in. reinforcing bars spaced 6 in. on the average were placed 2 in. from the bottom of the slab across the trench to carry

the load. Since this system was put into operation there has been no further trouble in the city from sunken paving over street openings.

Street car tracks are another source of trouble on paved streets and if their sphere of influence is not curbed, the rest of the street is often ruined. The cause of this destruction is not hard to find, and its elimination may be accomplished by the combined use of two types of structures, the steel paving guard, and the sunken header curb outside the end of ties.

Where stone and gravel ballast is used for street car tracks, the destruction is more pronounced, for the wave motion of the street railway track under the effect of the moving loads tends greatly to disturb the adjacent pavement. This, however, is a minimum where the grooved rail is used, but where T-rails are used the wheels of wagons and trucks when turning out of the track exert a strong leverage on the paving surface and grind or loosen whatever paving materials are in the way. If the paving is loosened, it is not long before the effect of water and additional motion of the car track forces out the paving for a considerable distance adjacent to the tracks.

Under most franchises the maintenance of this pavement between and adjacent to the railway tracks is taken care of by the street railway companies and as the costs run much higher than the maintenance of the pavement on the street itself, the result is that the least possible work is done. In some cities the street railway company has adopted a new type of construction for their track wherein steel ties are used, embedded in concrete, with a minimum of 9 in. of concrete beneath the rail. This has gone far to cut down destruction caused by loose car tracks. Even with the use of a concrete base under the tracks the danger of damage to pavements by wheels of wagons and trucks is still present where T-rails are used. This can largely be eliminated by the use of a grooved guard.

Wherever the flexible type of construction of street railway tracks is used, however, it is practically impossible to eliminate the bad effects of the moving track and it is therefore necessary, if the adjoining pavement is to be protected, to completely isolate the street railway track from the paving on each side. This matter is one which has been given great thought by many capable engineers and several designs have been made which accomplish their purpose admirably. In all of these designs the concrete sub-curb is used, extending down just outside the ends of the ties to a point several inches below the bottom of the street railway track ballast. On some pavements, such as concrete and wood block, this sub-curb can be extended up to the surface of the pavement, but it is hard to accomplish this without the use of a different paving material in the cast of asphalt or brick with a soft filler. Even these, however, can be built with the line of separation extending to the surface of the pavement if a metal paving guard is installed. This

being a steel angle with horizontal leg resting on the concrete and its vertical leg forming a line of separation in the paving.

The use of these header curbs separates the street paving into three units consisting of two shoulder or street pavements and the portion between and along the tracks. As the concrete in the track structure is separated from the concrete in the shoulder unit, any movement in the track structure will not be communicated to the adjoining shoulder. Movement is confined to each unit and does not interfere with the surface of any other unit. Movement caused by expansion or contraction or by loads on the tracks affects only the unit in which the movement originates. In some designs the separation joint is in the base only, and the paving is continued over the joint on the car track section. A line of separation exists between the track structure and the concrete header curb, but does not extend to the pavement surface. Consequently any upward and downward movement of the structure is communicated to the pavement to some extent and partially defeats the object of the header curb design.

The advantages of using header curb are several. It affords ample protection from poor track work and from the lesser movement of well constructed track. It allows tracks to be repaired or renewed without damage to the abutting pavement. Repaving of the track space will be done more quickly, as the two curbs will be at the proper street level, thereby serving as a paving line during such work. Any water caused by rains will very likely not be absorbed by the subsoil under the shoulders of the street pavement, even though the entire track may be removed, leaving a wide, shallow trench in the street. The header curb would form the sides of this trench and would serve as a retaining wall for the earth under the shoulders. It is for this reason, therefore, that the depth of the header curb is made such that its bottom would be several inches below the bottom of the ballasting of the track. The foregoing type of construction merits general adoption not only by city engineers, but also by highway engineers for ends of pavements at railroad crossings. It is inexpensive and acts as insurance against the destruction of good pavement by poorly maintained railway tracks.

The third and oftentimes the most dangerous portion of the street if not properly taken care of, is that portion which lies within the right-of-ways of railroads at grade crossings. The question of maintenance of pavement in this portion of the street is one which has occupied the attention of railway and highway engineers for many years. Many different types of surfaces have been tried with the usual reversion to the old form of plank crossing. No other section of highway must meet conditions as severe as those imposed upon the pavement adjacent to and between the rails of a grade crossing. The demands made on it are two-fold. It must satisfactorily fulfill the needs of highway traffic and at the same

time conform to railroad requirements. As a part of the highway built to carry modern motor truck traffic, the pavement must be of sufficient strength to carry the loads and withstand the impact caused by the wheels of heavily laden trucks. The surface must be as smooth and durable as the highway of which it is an important link. Railroad operation, on the other hand, requires that crossings permit trains to pass over them without shock, danger or undue noise. Railroad maintenance demands easy access to the ties and rails and that the crossing pavement be economically repaired and replaced.

A newer type of pavement for crossings has been evolved by experiment and bids fair to replace the plank construction. It consists of a base of crushed stone or gravel ballast placed and tamped solidly around the ties to a point within $2\frac{1}{2}$ in. of the finished grade. Upon this base is placed a bituminous concrete composed of crushed stone, sand and either tarvia, a cut-back tar product, or emulsified asphalt, thoroughly rolled and tamped to a smooth compact surface.

In laying this pavement at Whiting, the old plank crossing was removed and the ballast was taken out to the level of the lower surface of the ties. The ties and rail were carefully inspected, renewals made where necessary and the track was brought to grade. The space between and over the ties was then filled and compacted within $2\frac{1}{2}$ in. of the finished grade with crushed stone filled with screenings. Old rails were placed on each side of the new rails, with the ball of the old rail against the web of the new, so that the flanges on the old rails were vertical and acted as a retainer for the pavement, protecting its edges and giving ample flangeway for the car wheels. The pavement was then brought to grade by firmly tamping and rolling the bituminous concrete. This consisted of a mixture proportioned 1 cubic yard of $\frac{3}{4}$-in. crushed stone to $\frac{1}{3}$ cubic yard of sand and about 16 gallons of tarvia. These materials were mixed cold in a small concrete mixer, each batch being mixed until the stone was thoroughly covered with tarvia. This took about a minute and did not clog or stick in the mixer. After the mixing, the bituminous concrete was put in compact piles and allowed to cure for several days before placing. After this mixture had been tamped into place it was thrown open to traffic for several days before the seal coat was put on. The seal coat of tarvia covered with torpedo sand was applied and rolled thoroughly, producing a tight smooth surface.

The advantages of this type of pavement for crossings are many. Its simplicity appeals to the railway maintenance men, for the materials required to make repairs can be stored alongside the track and a section hand with a shovel, broom and hand tamper can mix the materials and apply a patch in half an hour. In this way the cost of materials required to maintain the crossings is un-

usually low, and it does not take a large gang or skilled men to do the work. Should the ties under this pavement require renewal or re-ballasting, it is a simple matter. Owing to the bonding qualities of the mixture the section of the paving thus removed and replaced soon joins with the undisturbed portion, leaving the crossing free from cracks and joints, presenting the same smooth and resilient surface as when it was first laid. From the traffic point of view, the smooth even surface at the same level as the bearing surface of the rail is highly desirable. The crossing is free from nails which might cause puncture or penetrate horse's hoofs, and there are no jagged splinters or sharp stones to cut up tires. The elimination of the bumps and ruts of the old types of crossings will be a blessing to all those who ride in cars and to those who use the pavements.

Smooth streets are an asset to any city. Their price is constant diligence in maintenance, and strict control of agencies that cut into or destroy our pavements.

THE ASPHALT PAVEMENTS OF THE FUTURE

BY ALLAN DIMMICK (*Prize Paper*)

It would be both rash and unprofitable to attempt to foretell with any degree of accuracy what type and description of pavements we shall be laying under the traffic conditions of ten years hence. Few forsaw the approaching breakdown of our 1910 highway system under the weight of the 1920 motor truck, but it is none the less true that those communities which in the past decade did give some thought to the future and realized to some extent the aggravated conditions to which pavements would be subjected, were able to make provision for the future traffic by adequate construction. It would therefore seem possible, and it is certainly important, that we attempt to realize the future trend in highway transportation, and provide for it in advance by adapting our roads and pavements to its needs with the best means at our disposal.

There is no question but that highway transportation is increasing in volume by leaps and bounds, and will continue to increase at least for many years to come. Whether or not the motor truck proves in the future a permanent and serious competitor of the railroads, it will be many a year before the latter are able to cope with the constantly increasing volume of goods in transit. Whether the size and weight of motor trucks will be greatly increased will depend upon possible future legislation, and until such is definitely obtained we have no choice but to anticipate greater loads that at present. In all events, we can depend upon it that the present maximum loads will, before long, be the rule rather than the exception. This forces the conclusion, already accepted by most highway officials, that the old style dirt, maca-

dam, and gravel roads can only be considered as an expedient, and though in many instances it will continue to be economical to utilize these cheaper forms of construction for subsidary routes, we must depend upon a more durable roadway for our principal country highways and city pavements. Asphalt pavements, which have been in use for half a century, and which are more widely laid today than any other of the so-called permanent pavements, will certainly prove one of the two or three possible solutions of the problem.

For many years the standard in asphalt paving was sheet asphalt, consisting of a more of less ''close'' binder course, and a ''top'' or wearing surface of the standardized mix of graded sand, pulverized mineral matter, and asphaltic cement, laid on a portland cement concrete foundation, usually six inches thick. During the past twenty years the asphaltic concrete pavement has been developed, and at present competes closely with sheet asphalt in popularity. This construction has taken two forms, the bitulithic or coarse-mix pavement, which has been protected by patents, and the Topeka mix, in which a smaller aggregate is used, and which was shown in 1912 not to be an infringement of the bitulithic patent rights. The basic patents covering the bitulithic mix have now expired, and the American Society of Municipal Improvements, at the 1920 convention, adopted a specification which includes both the Topeka and the bitulithic mixes under the single head of asphaltic concrete. In actual practice asphaltic concrete may be said to cover any asphaltic pavement consisting of a graded aggregate of stone, sand, pulverized mineral matter, and asphaltic cement. In other words it is concrete in the true sense, with asphaltic cement as the cementing medium, just as portland cement is the cementing medium in portland cement concrete.

The two types of asphaltic wearing surface, sheet asphalt and asphaltic concrete, will probably always have their adherents, and both will undoubtedly continue to be laid in accordance with local conditions. It is the foundation which underlies the wearing surface which has received the most discussion and which most merits consideration in planning for the future.

Unlike sheet asphalt, which until recently has been almost universally laid on a portland cement concrete base, asphaltic concrete has been largely laid on other foundations. Old pavements of brick, granite block, macadam, gravel, and portland cement concrete have been utilised as foundations, and large quantities have been laid on newly constructed bases of crushed stone. However, the foundation which is now most in the public eye is the asphaltic concrete base constructed in much the same way as the wearing surface, of a mixture of crushed stone and asphaltic cement.

At the 1920 meeting of the Illinois Society of Engineers, Professor C. C. Wiley of the University of Illinois, presented a very

interesting paper interpreting the impact tests on roads, conducted by the U. S. Bureau of Public Roads. These experiments have not yet been carried far enough to do more than show that as the weight and speed of loads increases, the impact resulting is a very serious and damaging force. It is obvious that a 10-ton truck, traveling at a fair rate of speed, passing over a depression of ½-in. in a road surface will deliver a considerable blow; and a series of such blows will deepen the depression, and the deeper the depression the greater the blows, and so on ad infinitum, with the ultimate result of cracking and shattering the rigid base itself.

The obvious conclusion of a study of this question of impact is a grave doubt as to whether the principle of rigidity has any place in the highway engineer's cosmos. Would the substitution of a resilient and shock-absorbing material for a rigid and frangible material tend to absorb or alleviate the impact, which—far more than the mere friction or suction resulting from the wheels of passing vehicles—is going to batter and destroy our roads of the future? Those who for many years have advocated the laying of asphalt pavements on an asphaltic base have urged this destructive effect of impact, and have drawn the analogy of an anvil, to which they compare the portland cement concrete base on which the wearing surface is pounded by heavy traffic. In the past, asphaltic surfaces on portland cement concrete foundations have given such good service that this contention has not been very seriously heeded but if the impact delivered by a moving truck may be more than five times the static load, as is shown by the Government's tests, an increase in the size and speed of loads becomes a very serious matter, and any suggestion as to possible means of reducing or absorbing the impact should be given careful thought.

One destructive result of heavy traffic is displacement or internal disturbance of the wearing surface, as evidenced by pushing, waving, rutting, or rolling. This has been explained by Mr. Francis P. Smith and Mr. Monroe L. Patzig as due to the effect of the successive impacts set up by the springs of heavy vehicles, as well as by the frequent sudden application of brakes, and turning of motor vehicles. Mr. W. L. Hempelmann, in a series of experiments conducted at St. Louis, has also shown that the difference in temperature at different depths beneath the surface of the pavement may be sufficient to result in altered consistency of the asphaltic binder, causing internal displacement.

One great advantage of asphaltic pavements is that by adjusting the mix, the pavement may be adapted to meet a great variety of conditions, and where this displacement is strictly an internal movement of the wearing surface, the particles of the aggregate moving upon each other, it may be overcome by the laying of a tougher wearing surface with an asphaltic cement of lower penetration, which is not highly susceptible to extreme atmospheric temperature changes, and with a greater proportion of fine mesh

material. However, it is probable that in many cases this displacement is simply a slipping of the entire wearing surface over the portland cement concrete foundation, to which it is not integrally bound, having indeed nothing to hold it in place but the forces of gravity and friction. A more or less effective mechanical key is now obtained by roughening the concrete, and asphaltic surfaces are being laid considerably harder than was thought of ten years ago and will undoubtedly be laid still harder in the future.

Still there is at least a question whether it will not be found profitable under the increasing volume of traffic to remove the cause of this defect and prevent any possibility of slipping by substituting for the comparatively smooth and unrelated portland cement concrete, a foundation which will be postively bound to and homogenous with the wearing surface, as an asphaltic base would be. In the case of either sheet asphalt or asphaltic concrete laid on an asphaltic concrete base, the necessity of a binder course is naturally eliminated by this construction.

Some hesitancy has been expressed as to whether asphaltic concrete foundations would be capable of supporting the heavy loads of the future. Of course no pavement supports any load, not even its own, otherwise our bridges would consist of 4-in. concrete slabs, unsupported except at the ends; it is the subgrade which must support the load, and the function of the foundation is not primarily to support the wearing surface, but to transmit the load and distribute it over the subgrade area. This principle is only beginning to be fully realized in highway engineering circles, and though leaders in the profession preach drainage continuously, it is a foregone conclusion that still greater importance will have to be attached to proper preparation of the subgrade if we are to have general success with our future pavements.

Where an asphaltic concrete base is used, a first-class subgrade, proof against any side-infiltration of water, is essential, as such a base, not being in the nature of a rigid slab, has little or no power to bridge over weak spots in the subgrade. This is by no means a defect, as it places the responsibility of carrying the load squarely where it belongs, on the earth, instead of relying on a comparatively thin and weakly supported slab to carry heavy loads over soft places. On an adequate subgrade an asphaltic concrete base has ample stability to transmit the heaviest loads. It is presumed that the angle of diffusion of load is approximately the same for asphaltic concrete as for portland cement concrete, and when we take into consideration the factor of resiliency and absorption of impact it is reasonable to suppose that the same or less thickness of asphaltic concrete would be equivalent to a given thickness of portland cement concrete in transmitting loads.

This principle is at present being carried to excess in actual construction; whereas 4-in. is the minimum and 6-in. the average for portland cement concrete bases, $3\frac{1}{2}$ in. has been considered the

maximum for asphaltic concrete foundations and 2½ in. has been probably the average. This places much too great an estimated value on the shock-absorbing ability of the asphaltic concrete, and does not allow sufficient mass or thickness for the proper diffusion of load. It would seem better practice in constructing asphaltic concrete bases equivalent to the standard 6-in. portland cement concrete to lay the base in two courses of 2 in. or 2½ in. each. The successful use of the thin asphaltic concrete bases, 3 in. thick or less, under present traffic conditions, should be considered as evidence of the possibilities of this form of construction, but should not be relied on implicitly as a guide to future practice.

Asphaltic concrete foundations have not been used in Illinois owing to the lower price of portland cement in past years, but they have been successfully employed in the western states for the past 24 years. Mr. C. S. Pope of San Francisco states that over 50 municipalities in California alone lay asphaltic concrete foundations, and over 3,000,000 yards of the bitulithic or coarse mix alone have been constructed on this type of base in eight western states. The present practice is to construct the base in the same manner as the wearing surface, using a mix consisting of asphaltic cement 5 to 8%, mineral aggregate passing a ¼-in. screen 25 to 40% and retained on ¼-in. and passing 2½-in. 50 to 70%.

Naturally enough, constantly increasing care is exercised in the construction of this type of base. The old ''black'' base of 20 years ago was usually merely a layer of crushed stone, more or less penetrated with bitumen, frequently tar or some nondescript brand of asphalt of unknown origin. Of course the results obtained, however encouraging, should not be compared with a pavement constructed on a modern base, machine mixed, with carefully graded aggregate, and an asphaltic cement of high quality

In view of these considerations, is it too much to hazard a guess as to the probable trend of asphalt pavement construction in the future? To expect that much more care and attention will be given to preparing, draining, and thoroughly compacting the subgrade; that asphaltic concrete foundations will be largely utilized; that the asphaltic mixture used in the wearing surface will be a stiffer mix than that usual at present; and that the object of the engineer will be, not to bridge over a spongy subgrade with a thick, hard and rigid slab, but to secure a tough, homogenous, and resilient pavement that will absorb the impact and transmit the weight of increased traffic to the earth beneath?

ALIGNMENT AND GRADES FOR MODERN ROADS

BY R. E. TOMS

Senior Highway Engineer, U. S. Bureau of Public Roads, South Chicago

The common use of the automobile and truck have so increased the radius of travel that roads are now state and national in their importance, and the matter of their proper location is of vital

concern. With this increase in importance, the administrative control of these roads has passed to the state, the cost of construction has risen to approximately $40,000 per mile and the volume of traffic has increased to proportions undreamed of a decade ago. Under these conditions any deviation from the proper location entails a considerable increase in the cost of construction and also in the operating expenses of the users of the road due to the increased distance. If we estimate the cost of operation of motor vehicles at 7 cents per mile, a very conservative figure, the increased cost of operation for a traffic of 500 vehicles, the minimum to be expected on main trunk roads, would be $12,775 per mile per year and for a traffic of 1,000 vehicles, $25,550.

In the location of highways between any two controlling points there is usually a well defined traveled way which follows the general direction of a straight line between the points. As settlement has followed this traveled way, consideration should be given this factor in preference to the absolutely straight line location. In a sectionized country, the present roads not infrequently jog at right angles to the direction of travel for a mile or more before continuing on in that direction. In the improvement and betterment of these roads, a location following these jogs cannot be justified unless it is necessary to intersect some other trunk line road. On the basis of an original cost of $40,000 per mile the actual saving in cost of construction by locating diagonally across a section of land would be $24,000, and the saving in distance would be 0.6 mile over the location following the sides of the section. On this basis the state could afford to pay the entire saving in cost of construction, $24,000 or at the rate of approximately $40 per acre for the whole section, to the landowners as damages and the investment would still be highly profitable. There would be less mileage to maintain, and the decreased maintenance and operating cost to the general public would represent annual savings. Section lines should be disregarded almost entirely in considering relocations for betterments and improvements of our highways, and prime consideration should be given to securing the shortest possible distance between controlling towns.

Next in importance to directness of alignment is curvature. Considerations of time demand that curves be negotiated at no material reduction from the average road speed. Considerations of safety require a radius of curvature such that sufficient sight distance is secured to avoid possibilities of collision. If we make our curves flat enough to be negotiated without any reduction from average road speed, we will at the same time have provided ample sight distance. Some objections have been raised to flat curves because it is claimed they tend to encourage high speed traffic. Various attempts have been made to control the speed of motor vehicles and throttle them down to medium and slow traffic by the passage of statutes providing for maximum speeds of 15 to 25

miles per hour. They have had no effect, because there exists in the mind of every automobile driver a maximum speed which he considers safe to travel, and 95 per cent. of car owners believe this maximum speed to be in the neighborhood of 30 to 35 miles per hour and drive accordingly. This speed moreover has been adopted as the legal speed in the more enlightened states.

In making our curves safe for high speed traffic, therefore, we are not encouraging high speed traffic but merely providing safety for the class of travel that actually exists. A minimum radius of curve for a speed of 30 miles with a superelevation of curve of one inch per foot of width, will be approximately 500 feet. Now let us examine the item of cost for curves of different radius. Curves of minimum radius, whatever the minimum established, nearly always occur at section corners or right angle turns in the alignment, and usually to secure curves of greater radius than 40 feet, aditional right of way must be obtained. On the basis of a construction cost of $35,000 per mile the following table shows the right of way required, the saving in distance and the construction cost for curves of different radius for 90-deg turns:

Radius ft.	Length of curve ft.	Length around tangents ft.	Saving in Distance ft.	Right of way required acres	Saving in cost of construction	Value of acre measured by the saving
200	314.16	400	85.84	0.137	$ 487.74	$3560
300	471.24	600	128.76	0.351	731.61	2084
400	628.32	800	171.68	0.663	975.48	1471
500	785.40	1000	214.60	1.072	1219.35	1137

Comparing curves of 200-ft. and 500-ft. radius, it will be found that the latter is 128.7 feet shorter between terminal points and costs $731 less but requires nearly an acre of additional right of way. The saving in operating expense for this shorter distance for a traffic of 500 vehicles at 7c per mile would be $312 per year, which capitalized at 5 per cent. would justify an expense of $6,240. Disregarding the saving in operation, the State can afford to pay at the rate of $700 per acre, an excessive figure, for the additional right of way necessary to construct a 500-ft curve instead of a 200-ft. curve. In the case of intersecting roads, the minimum curvature for safety of travel will govern. As this is approximately 500-ft. radius, no curves of shorter radius should be used in a country where this curvature can be obtained without unreasonable expense for grading. In rough hilly country, curves of shorter radius should be used and safety for travel secured by widening the curves.

There are several methods in general use for widening curves. Notably the "lune" method, and widening on the outside by using a concentric circle. The "lune" method consists essentially of

passing a curve of larger radius through a point at the middle of the curve where the maximum widening is obtained and then diminishing both ways to zero some distance from the point of curve and point of tangency. This method gives a curve that is pleasing to the eye but is wrong both in theory and in practice.

Necessity for widening curves exists both at the point of curve and at the point of tangency, and practically the full width of widening must be obtained at these points. This full width of widening for the entire length of curve can only be obtained by the use of concentric circles placed either on the outside or the inside of the curve and tapering off to the original edges of the pavement at certain distances from the point of curve and the point of tangency. Widening on the outside disregards one important element—the psychology of the driver. To utilize outside widening, the driver must turn away from the direction of travel. In curving to the left he must turn to the right first, and the average driver will not do this, except to avoid collision.

The logical method of widening curves, therefore, is on the inside, with full width of widening for entire length of curve, diminishing to zero in a distance of at least 100-ft. on either side of point of curve and point of tangency. As the rear wheels of ordinary vehicles are fixed, causing them, when rounding curves, to travel on a different radius from the front wheels, additional width of surface must be provided on curves of short radius. This added surface will vary with the radius of the curve, the gage of the wheels and the length of the vehicle. If we assume two vehicles of maximum size, trucks with 204-in. wheelbase, 5-ft. gage, 8-ft. wide, the amount of theoretical widening required may be readily determined. If we apply these theoretical considerations only we will find that for curves of over 150-ft. radius the amount of widening required will be almost negligible. There is, however, the personal equation. The driver of a motor vehicle will not follow a true curve but inclines away from the outer edge and toward the direction of travel, so that additional clearance for vehicles must be provided on curves.

The width of paving on main roads should be at least 18-ft. with our present traffic, with a 20-ft. minimum in the neighborhood of large cities where a large volume of truck traffic exists. On 18-ft. roads, touring cars have 4½-ft. clearance in passing and a touring car passing a truck of a maximum width will have only 3-ft. clearance. The amount of truck traffic in comparison to passenger motor vehicle traffic, except in the neighborhood of large cities, is comparatively small, so that the frequency of two trucks passing is almost negligible in comparison with the frequency of a touring car passing a truck. Ample clearance, therefore, for touring car and truck will provide the maximum of safety for road travel at the minimum of cost. For this condition of travel our clearance on tangents is 3 ft.

On curves, therefore, this clearance should be 3 ft. plus an allowance for the personal equation or a total of 5 ft. This amount of clearance coupled with the theoretical consideration will determine the amount of widening necessary. On this assumption an 18-ft. road should be widened, as follows: for curves of 100 ft. radius, 4 ft.; 200 ft. radius, 3 ft.; 300 ft. radius, 2½ ft. A 20-ft. road assumes a condition of travel where the frequency of truck passing truck will be a big factor, this condition should govern the amount of widening used on 20-ft. roads. On curves of greater radius than 500 ft., no widening is necessary. The only objection to widening curves seems to be on the part of the contractors. They are of course, somewhat slower of construction and usually require hand finishing, but the average number of widened curves would be considerably less than one per mile of road.

Table of Curve Widening.

Radius of Center Line	Addt'n'l Width Rdwy. Required			Radius of Center Line	Addt'n'l Width Rdwy. Required		
	16-ft. Road	18-ft. Road	20-ft. Road		16-ft. Road	18-ft. Road	20-ft. Road
ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.
30	8.0	11.0	14.0	125	3.5	4.0	4.0
40	6.0	8.0	9.5	150	3.0	3.5	3.5
50	5.5	6.5	7.5	175	3.0	3.0	3.0
60	5.0	5.5	6.5	200	3.0	3.0	3.0
70	4.5	5.0	5.5	250	3.0	3.0	2.5
80	4.0	4.5	5.0	300	3.0	2.5	2.5
90	4.0	4.5	4.5	400	3.0	2.5	2.0
100	4.0	4.0	4.0	500	2.5	2.0	2.0

Note: Computations for additional width required for 16-ft, roadway are based upon the passing of two touring cars of 144-in. wheel base, with 5 feet of clearance. A 16-ft. road is not considered safe for truck travel. Where such traffic exists, 18-ft. or 20-ft. width should be used.

For modern traffic it is becoming customary and desirable to superelevate all curves to compensate centrifugal force. The superelevation used by the Illinois State Highway Department has proved very satisfactory, as follows: for curves up to 800 ft. radius, 1 in. per foot of width; ½ in. for curves of 800 ft. to 2,000 ft. radius, and ¼ in. for curves 2,000 to 6,000-ft. radius. Maximum superelevation should be obtained at the point of curve and continued for the entire length of curve, running out the superelevation in 100 ft. from each tangent point.

With the increase in traffic, it is becoming increasingly important to separate grades at railroad crossings. Where the cost of separation is paid wholly by the railroads, they usually insist on placing structures at right angles to the line of the railroad, without regard to the alignment of the highway. This relieves the

railroad of liability for accidents at a minimum cost. Such practice, however, has resulted in subways and over bridges being so located that very sharp turns without any appreciable sight distance are necessary in the highway alignment. A grade separation that does not provide sufficient radius of curves and sight distance for safety of average speed highway travel, may be more dangerous than a grade crossing. A properly constructed grade separation where curves in the highway alignment are necessary should be skewed with the railway sufficiently to provide for at least 150 ft. of tangent at the structure itself and curves of 300 ft. radius at each end of this tangent. In the case of overhead crossings, where ascending approach grades are necessary, vertical curves of a minimum length of 200 ft. will be required at each approach to provide proper sight distance. The cost of grade separation is now usually divided between the state and the railroads and under such division it is possible for the state to obtain the proper location for grade separations.

Grades and alignment are more or less interdependent and frequently one can be bettered only at the expense of the other. Curves at the feet of steep grades are objectionable and a constant source of danger. For grades under the maximum, it is believed that grades should be sacrificed to secure better alignment. Whatever the future developments of travel may be there will always be a certain amount of horse-drawn traffic on our roads. For this class of traffic, grades are the limiting factor in determining the size of load. With the motor vehicle, however, due to its flexible power, grades do not limit the size of load but determine only the amount of power expended. If we determine upon a maximum grade, therefore, for efficient horse travel, we will automatically have provided for motor traffic.

At the present time we do not know definitely the effect of grades upon the cost of operation of motor vehicles, so this relation cannot be expressed in dollars and cents. Generally speaking the higher the type of road, and the smoother the surface, the lower the maximum grade should be. For horse drawn traffic, due to the fact that a horse can exert a greater effort for a short period of time, it has become somewhat general practice to use a sliding maximum. A grade of 5 per cent. is generally assumed as the ruling maximum, with not over 700 ft. of 6 per cent. or 400 ft. of 7 per cent. grade. Practically all automobiles can ascend these grades without the gears being shifted and can be controlled on the descent with the foot brake. These grades, therefore, may be said to be maximum grades for safety, but for economical operation the rate of grade must be maintained as much below the maximum as will be consistent with construction cost.

BETTER ROADS OF CONÇRETE

BY S. T. MORSE

Among the most frequent objections to the present concrete roads are: 1, insuffficency of width; 2, tendency to crack; 3 rapid wear and abrasion of surface, and 4, high cost

State highway authorities are at present building roads ranging in width from 15 to 24 feet. A number are using 16 feet as the standard. From a standpoint of safety and of utility, a width of 16 feet is narrow. The purpose of an improved road is to permit rapid, unimpeded progress, and a road of this width defeats this purpose. Mention may be made of four miles of State highway, 16 ft. wide, constructed in 1920 from Benld to Gillespie, Ill., on which seven collisions have occurred in seven months, all damaging, and all due in part to the narrow roadway. No improved surface should be made less than 18 feet, and for purposes of ultimate economy and utility a width of 20 ft. for double line traffic will provide a fair allowance for future growth in density, speeds, and width of vehicles.

As beam span is increased, the thickness must also increase, if rupture is to be avoided, hence the present effort of engineers to hold down the width of roads of concrete, thereby avoiding the undue expense of thick slab construction. The lowest permissible thickness for properly designed slabs 20 ft. in width is 10 in. which provides no allowance for reduction by wear, whereas the required thickness for concrete slabs 10 feet in width is about 0.6 in, and adding one inch to offset the probable wear of 20 years of service gives 7 in. as the correct specification for this width. Therefore pavements may be economically built 20 ft. in width by constructing two adjacent slabs 10 ft. wide joined by a protected longitudinal joint. This method has been tried with success and solves the wide pavement problem.

Engineers are familiar with the irregular, unsightly, central crack which frequently appears in a percentage of the slabs of most concrete pavements, caused, it is conceded, by unequal upward movements in the shallow subgrade when frozen in a saturated or even damp condition. The writer's method of solving these troublesome sub-grade problems is by reliance on slab design, not neglecting efficient drainage, nor yet depending upon it. Concrete pavement slabs which will not crack longitudinally may be produced in one of three ways: by increasing present thicknesses, by reducing slab widths, or by increasing the strength of the concrete, as by means of a richer mix, or a dryer mix well tamped.

Cracks extending across the roadway appear to be even more difficult to control. The writer is convinced that very few of these cracks are caused directly by the contraction or shrinkage of the concrete slab, but that the great majority are caused by the same phenomena which cause the long central cracks; the unequal upheaval of the shallow foundation by frost and moisture. Some por-

tions of a roadway are less compact and dense than others, and the water tends to gather in these places which on freezing, are heaved a proportionately greater amount, causing unequal stresses along the pavement edges. The writer has observed this inequality to be, at times, as much as ¾ in., which in most cases would prove to be enough to cause a transverse crack, since the strain extends radially from the point of greatest upheaval.

An integral curb is of much assistance in reducing the number of such cracks; perhaps a small amount of steel in the top of such a curb will still further reduce this tendency to fail. It at least seems to be certain that the sides of a concrete road, where no curb can be used, should be made at least as thick as the central thickness. It may be found by future experiment and experience, that on country roads where a curb is objectionable, a reversed curb extending downward for several inches, and having steel rods embedded near the base will prove to be a material saving in maintenance costs by eliminating the transverse cracks, where a sufficient number of transverse joints are included to care for contraction.

Concrete pavements, as now constructed, appear to be giving very fair service as regards the wearing surface. There are several points, however, by which pavements might be improved in this respect. Some of the earlier roads constructed of gravel have been found to wear unevenly, there being many soft stone among the harder pebbles. Uniformity of the stone and the absence of dirt are requisites for long service. Even well-made pavements of concrete wear much more rapidly than is usually supposed. Eight years ago the State Department constructed at Carlinville a well-made pavement with a 1:2:3½ mix. At that time the writer placed a few nails flush with the surface, these now protrude an average of 5-16 in. The stone is a fair grade of limestone, and the mixed traffic averages from 600 to 800 vehicles per day. As the traffic will probably increase, this would indicate that a reduction in thickness of one inch may be expected within 20 or 25 years by the abrasion of traffic. One inch, therefore, is a fair amount to allow in designing for surface wear with present mixtures and methods.

A harder and more durable surface than that now provided is very desirable, and such a surface seems to be easily obtainable at a small additional cost, perhaps even at a saving in cost. The tests conducted by Prof. Duff A. Abrams at Lewis Institute have demonstrated that the compressive strength of concrete increases in a marked degree as the richness of the mix is increased from 1-2-3 to about 1-1-2, the increase noted being about 40%. He has further demonstrated that the abrasive resistance increases in proportion and to the same degree as the compressive strength. By employing a 1-1-2 mix, it may fairly be assumed therefore, that even in practice, an increase in strength and durability of 33% may be se-

cured above the present prectice. The thickness of the slab need be made only sufficient to avoid rupture under the superimposed loads, and since the required thickness decreases as the square root of the unit stress increases, it is manifest that a 33% increase in unit stress permits a decrease in thickness of about 15%, so that if six inches provides sufficient strength for a slab 10 feet in width with a 1-2-3 mix, and if one inch be added for wear, a thickness of 5.1 inches will provide the same strength with a 1-1-2 mix, and 2-3 in. will be the equivalent allowance for wear, so that a total thickness of 5¾ inches of a 1-1-2 mix provides the same strength and durability as 7 inches of 1-2-3 mixture.

Reduction of cost is properly divided into the initial cost of construction and the cost of maintenance. The problem in pavement design is to produce the thinnest, best, and cheapest cross section which will under no usual conditions fail structurally, to which must be added a definite allowance for the wear of traffic during the expected life of the pavement. For widths in excess of 16 ft., the divided slab method of construction mentioned above secures these results in a most efficient manner; for wide slabs made thick are dear, and wide slabs made thin are costly in maintenance and unsightly in their failure. Maintenance costs will be much reduced by the elimination of structural failures, and by the use of the richer mixtures which check the abrasion of the surface, at joints, and at cracks, at no greater initial cost, probably at a saving. An item of large present importance, not readily expressible in dollars, lies in the fact that a much greater mileage of improved roadways may be built per annum by using the thinner, better cross section of pavement.

DESIGN OF BRICK PAVEMENTS

BY M. B. GREENOUGH

Not so long ago efforts were being made to create "standard" types of paving that could be used universally, with as much economy in one place as another. All this effort must have rested upon one assumption, that conditions surrounding every paving project were standardized. The trend of engineering practice today is toward the selection of forms of paving that best satisfy the requirements of the particular project. Eventually as much care, in proportion to the nature of the work, will be bestowed upon the examination of a paving project, in securing the fundamental data necessary for economic designing, as would be exercised in securing facts for the design of bridge piers or high building foundations.

A brick pavement is a composite structure having three elements: wearing surface, bedding and foundation. The relation between these is clearly defined, and the necessary data for design assembled, by beginning the analysis with the foundation.

Foundation. By this we mean the natural soil underlying

the pavement plus the artificial base, if such is required. The two must be studied as one element. Where the natural soil is well-drained and therefore probably stable, less requirements are exacted from an artificial support. Where the natural soil seems unsuitable the designer may improve the character of the sub-soil or he may throw all the burden of pavement support upon the artificial base. This last procedure results in waste and inefficient pavement construction, as we must then build our pavement bases as bridges, and the cost of such construction as would accomplish what is intended, would be prohibitive. In the long run it is cheaper to improve deficient sub-soils, once and for all, than it is to repair broken-down pavements.

By a thorough sub-soil study in each case of brick pavement design, we establish whether or not an artificial base is needed, and how much of a given kind of base is required. Many forms of artificial bases are adequate, under proper conditions, for brick pavements; for example, concrete (hardened or green), rolled stone, gravel or slag, screenings or bituminous bound; and worn macadam or concrete pavements. Single projects may be underlaid with several types of bases according to the nature of the natural foundation. In many cases no artificial base is required.

Bedding—This serves, like the artificial base under proper conditions, to transmit loads and forces, and probably to absorb a certain amount of them. It is a means of securing a smooth surface. But if the bedding is not in proper accord with the rest of the structure, a succesful pavement may not be had. The controlling consideration is the composition of the filler between the brick. If this is of a kind, like asphalt or sand, that permits slight movements under traffic, of any single brick, then the bedding must likewise permit this movement. If the filler is cement grout and the movement is of the surface acting as a slab, then the bedding must act similarly.

The general practice of engineers today is to use sand and similar materials in conjunction with bituminous and sand fillers. Where the filler is cement grout, the bedding may become one with the base, as when the brick are laid in green concrete, or a cement-sand bed may be used. Thus the distinction is drawn between ''flexible'' and ''rigid'' brick pavements. The use of cement grout filler predicates the adoption of a concrete base and thus creates a ''rigid'' type of pavement, while many other bases, in addition to concrete, are available for the ''flexible'' types. With the ''flexible'' type of pavement, less base compared with the ''rigid'' is needed, if loads are properly transmitted to suitable sub-soils. The development of the practice of using brick 3 in. deep with a ''flexible'' filler, rests upon the above distinctions. And we find, in most instances, brick of the 4-in. depth used in the rigid types of construction.

Wearing Surface. We need wearing-surfaces which possess

endurance in proportion to all possible future demands of traffic. Correctly built brick pavements are enduring under traffic and the brick themselves are practically immune to the disintegrating influences of natural forces like water and frost.

NEED FOR RESEARCH IN HIGHWAY PROBLEMS

BY C. C. WILEY

One great handicap in road building today is the lack of definite scientific knowledge of many of the underlying principles involved, or at least of their method of application to the problems of the roadbuilder. We talk of ''designing'' pavements but in fact we do very little true designing. Some few things we do understand and can apply but on the whole we employ only the time honored method of guessing. Now the highway engineer faces the problem of developing types of construction to handle motor truck traffic, and this while confronted with the task of actually building miles and miles of roads.

How can these problems be solved? By organizing and developing a comprehensive scheme of highway research. First we must free ourself from the divine right of politicians to override at any moment the scientific knowledge, best judgement and dictates of experience of the man who is making the work his life's study.

The second part of the work is scientific study into the physical problems of the design, construction and maintenance of highways. These problems may be divided into two groups, those that deal with the location or the establishment of line and grade, and those that have to do with the roadway structure. In the first group the general principles have been pretty well established. Nearly a hundred years of railroad building have solved many of them but how slow we have been in adapting the results to our highways. Take for example superelevation. Its scientific principles are well known. But how slowly we have put it into service on our highways.

The second part of road building deals with the roadway itself and it is here that our sum of knowledge is deficient and therefore here is the greatest field for study. We all agree that drainage is an important element. But what do we know about how to drain and how are we going to know until we know something more of the soils themselves, the efficiency or behavior of different types, location and details of drainage structures and a thousand other things relating to the necessity for and methods of removal of the water from the surface and the subgrade? Some of these things have been studied but not thoroughly from the standpoint of the roadbuilder.

What do we know about loads or the distribution of loads? We can of course determine the weight under a given wheel but

that is not necessarily the load on the pavement. Until very recently we paid no attention to impact. And how can we expect to really design a pavement until we really know something about the loads? What do we know about the proper way of preparing a subgrade, or about expansion? Is it not going at the problem backwards to attempt to reinforce concrete pavements when we know little or nothing of the origin, magnitude or location of the stresses we are trying to meet? Why do we assume that expansion is due to a uniform change of temperature throughout the slab? Would it not seem that ordinary reasoning from known facts would point out the possibility of there being different temperatures at different points and that the unequal stresses resulting might have something to do with the behavior of the slab? Incidentally this problem is being studied at the University of Illinois. For a bridge or dam or building we go down to a solid foundation. We try to get below frost and seepage and we try to proportion parts with a margin of excess strength. Our pavements float above the frost line, often on a sea of mud whose strength or behavior we know nothing about and in addition we are compelled to shave close to ultimate strength.

Two things are needed. The development of a comprehensive co-operative scheme of research and the financing of the project. At the beginning of 1920 it was estimated that over $600,000,000 were available for road work, and no guess was made at the amount for city streets. Is 0.1 of one per cent. too much for study? That is a $1,000,000. Who would think of spending that sum on road investigations? But frankly would it not be better to spend $1,000,000 on study rather than to spend the whole amount on a guess?

DESIGN OF TILE DRAINAGE SYSTEMS

BY JAMES W. DAPPERT

Topographic Survey.—To determine the plan of drainage so that it can be economically installed a topographical survey is necessary, with the determination of sufficient elevations to make a close topographic map. This may be done by stadia readings, but I can cover more ground per day with a wye-level, using a small pocket level and compass combined, to fill in the details, and in this way cover from 100 to 300 acres per day. The more flat and level the tract, the longer the station intervals, and the more rolling the tract, the more carefully should the elevations be taken. Usually the elevations are taken at intervals of 100 ft., 300 ft. for very flat lands. In either case the location and elevation of all depressions, ridges, extremely wet spots, ponds, streams, fences, and buildings should be taken sufficiently close for plotting. Test pits should be dug, the soil investigated, elevation of any hard or soft strata determined, sample of any unusual varieties of soils taken for future test and study; all these data to be finally plotted upon the map.

During this preliminary survey and investigation, it may also be necessary to make a survey for some distance away from the tract to secure a proper outlet, and a close sketch of the creek, branch or other watercourse and its surrounding objects should be made, with measurements sufficient to design a bulkhead or retaining wall at outlet of tile-drain. This survey should also be made with a view to the possible construction of catch-basins, inlets or wells. These should be placed at fence lines where possible, or at the margins of fields, where they will be least in the way of cultivation or use of the land. It is better to take all possible data of this kind while making the topographic survey, rather than to have to make another long trip later.

Utilizing Old Tile Drains.—Frequently it is found that some system of tile drains has been laid before, generally with tile too shallow to drain the land properly. These should be followed out as far as possible, determining their location by digging holes or trenches where the tiles are suspected, until a mixed soil is found, indicating that the soil has once been dug. These old drains should be plotted on the map. Where these drains are helpful in draining the land, are in good condition and are laid in the proper course, they may be utilized in the new plan. In some cases such drains are found in the construction of the new system. Where the new drain is lower it may be connected with the old one by a Y-junction, the dead end of the old drain being closed by bricks and cement. If the distance is too great for a junction, a small well of brick may be built to connect the two drains.

Designing the Drainage System—With the topographic map before him the engineer begins the study of his problem, and all the time spent upon it is fully justified. Where areas are flat and the contours rather far apart, the plan should be to cut the contours at about right angles with the drains. When you design a system with the laterals spaced parallel to each other at regular intervals, it will often be found that you cannot locate all of them at right angles to the contours. I would allow considerable leeway to this rule, so long as the laterals in regular spacing will cut the contours at an angle up to 45 degrees from perpendicular, after which a new main or sub-main should be installed in some depression which will admit of a considerable area being reached with a parallel system of drains. Where very flat areas cover considerable territory, it will be found necessary to insert some sub-mains at intervals, rather than to carry the lateral drains for long distances upon too flat a grade. Also, this method saves going very deep at the lower end, and very shallow at upper end of lateral, the sub-mains being held down to flatter gradients, and made sufficiently large to carry the water from the laterals.

Upon lands which are rolling no regular rectangular or gridiron system of lateral drains is applicable, and this kind of land is the most difficult upon which to plan an elaborate system of

drainage. The low swales rapidly catch the waters from the more rolling lands and become super-saturated, hence the lateral drains should be provided with more capacity than for flat lands where the accumulation of water is more gradual. In other words, the portions of a hilly farm that require tile-drainage at all require tiles of larger calibre than those upon more level land, if you wish to get the water into the drains, rather than to have it run away upon the surface, and thus prevent soil erosion. Where flat areas adjoin precipitous areas the laterals will generally need to extend well up the slopes, to cut the seepy spots, and should extend to the summit, or very nearly so, and the drain which goes far enough above the point of seepage so that its grade line is about level with the place where seepage discharges will be of more value for drainage than the lateral which goes directly through the seepy spot itself. The reason for this is that the seep itself is caused by a stratum of soft water-bearing soil overlaying a hard, impervious stratum which holds the water and carries it out to the end of the stratum.

Often these hard strata dip away from the draw or natural depression rather than toward it, as might be presumed, so that considerable exploration by borings or test pits is desirable upon such rolling lands. The drainage engineer should inform himself as much as possible about soil formations and soil characteristics, and when he becomes familiar with the various features of soil in a given locality he will be able to forecast, from surface appearances, some of the peculiar and well-defined characteristics of soil strata, wherever he sees them. This is especially true of the upper Mississippi valley, with some notable exceptions.

The depth at which tile drains should be laid is dependent largely upon the character of the soil. Usually the tiles work best when laid a few inches below the soft, water bearing stratum, and within the hard bottom below it. But it is evident that with a drain laid to the regular gradient this is difficult to accomplish, hence the more need for the test pits and a study both of topography and soil strata. Where the topography is precipitous, with contour lines close together, the cutting of the contours at right angles may not be the most desirable location of the drains. It frequently happens that a direction oblique to that of the contours may give the best results, and if a single drain does not cut off all the seepy places, the next parallel drain will do so.

Where the tiles could properly be laid to a good depth, the topography is often such as not to admit of it, and where the topography will admit of deep drains, as on rolling lands, the soil conditions are such that the shallower drains will better serve the purpose. As to depth and space interval, each drainage area is a separate study. I have laid tile drainage systems upon rather flat land with very friable soils. Again I have laid the tiles 132 ft. to 140 ft. apart upon rather rolling lands, and afterwards found it

necessary to double up by laying one new drain between each pair of older drains, to accomplish the same result. Upon the rolling lands, the soil is, most generally, not so friable as upon the flatter lands. Also, a drain laid upon a hill-slope does not reach out far to draw the water upon the down-hill side, hence the spacing must be close enough so that the contiguous drain will draw the water from the soil upon its up-hill side, from near the locality of the next drain.

Inlets and Catch Basins—In many localities where surface run-off is great, it will be necessary to install inlets and catch basins. This is especially true of the more rolling lands, where small branch drains, ditches and waterways have been made or have washed out by erosion. Upon such lands the soil and sub-soil are frequently impervious or partly so. The water cannot percolate down to the tiles as rapidly as it falls during heavy rains or in melting snows. It forms rivulets and washes away the top soils, and impoverishes the land. A catch basin, usually dug circular like a well, lined with brick or concrete, with its base also lined, and made from two 2 to 8 ft. deeper than the outgoing tile drain to form a silt basin, should be installed at fence lines where possible, so as to be least subject to injury by stock and from farming operations. Where necessary a small pen can be built to protect it.

These catch basins should have a grated iron frame and cover similar to city catch basins, and if necessary to install in a field under cultivation, may be left several feet below the general surface, at top of grade, and have a load of broken stone or gravel thrown over the top through which the surface water readily percolates. Where drainage areas are small, a T junction can be placed vertically in the tile drain and a run of pipe carried up to the surface, with a grated iron cap and cover. If in the fields where they would be subject to being damaged or broken they can be covered with brick bats, tile bats, corn cobs or gravel, which will admit surface water and prevent erosion. Where a system of water inlets or catch basins is designed as a part of the system of drainage, it is evident that greater run-off must be provided for than if merely drainage by percolation. The tile laterals and mains must be increased in size to allow for this or otherwise the basins and inlets will not accomplish their purpose, to prevent soil erosion.

Rainfall and Run-off—How large a drain should be to serve a certain area is a problem in itself. The landowners who pay the expenses often determine upon the sizes to be installed, but the engineer is usually called upon to use his skill and judgement in deciding the kind, character and sizes of drains needed.

In Illinois the variations of annual precipitation are as great as 14 in., which is 33 per cent. of normal precipitation in the state. The rainfall records of the U. S. Weather Bureau show as much as 11 or 12 in. fall in 24 hours in restricted areas and in unusual

floods. The run-off records in the state vary from practically zero to as great as 5 in. in 24 hours. By taking the extremes in any case we can arrive at no safe and sane conclusion as to how much run-off to provide against in designing a system of tile-drainage. We depend largely upon experiment and former experiences.

In a table of ''Drainage Co-Efficients'' used by a firm of engineers in southern Minnesota, I am impressed with the quantity of run-off provided for, which is greater than the quantities used in Illinois. The table shows a drainage coefficient of 5-8-in. for open ditches upon areas of 1.172 to 43,000 acres, 1½ in. upon areas of 3,850 to 9545 acres, all in terms of depth of water to be drained off in 24 hours. For larger tile laterals the same table shows run-off as follows: 1 in. upon areas of 7,300 to 5,000 acres; 3-4 in. upon one area of 828 acres, noted as very flat; 1½ in. upon area of 3,400 acres; 1 in. upon one area of 8,166 acres, all in terms of depth of water to be carried off by the tiles in 24 hours. By persistent effort upon the part of the writer, some modifications amounting to 50 per cent. reductions were made before the final report was submitted, and even then the run-off provided for was unnecessarily large, requiring the use of much larger tiles than needed.

If a run-off of from 3-4 to 1½ in. per 24 hours is required in southern Minnesota, it is also required in Illinois, where rainfall is greater. C. G. Elliott, in his ''Manual of Engineering for Land Drainage'' gives a maximum run-off of 1.03 in. per 24 hours for a district in Louisiana, where annual rainfall is twice as much as in Minnesota. That is an extreme case, most of the maximum run-off reported from actual water measurement, even in the southern states, being less than 3-4 in. per 24 hours.

From experience of 25 years or more, I find that for most flat and moderately flat lands in central Illinois a run-off of 1-4 in. per 24 hours is reasonable. If the areas are quite large, with considerable open ditch to convey floods, a quantity as low as 1-8 in. will be sufficient. If the areas are small, surface drainage wholly deficient, as much as 3-4 in. should be provided for. I find it convenient to have a table showing the run-off from areas of one to one million acres of land, in quantities of one inch down to 1-32 in. of run-off per 24 hours, said table being used in conjunction with a table of velocities and capacities of various sized tile pipes from 4 to 72 in. in diameter, figured from Kutter's formula at gradients of from one-hundredth up to one foot per 100 feet. Such tables can be prepared with a moderate cost in time and labor by calculating each fourth or fifth quantity from the formula, and interpolating the others, or can readily be produced in the shape of a graph.

Having determined from the survey the area to be drained, its characteristics, and rate of run-off to be applied, the table of run-off quickly gives you the quantity, which may be in gallons per minute or cubic feet per second, preferably the latter, which must be cared for upon the given tract. You now turn to the table of

capacities, and, under rate of gradient available, quickly find the size of tile which will convey as much as or a trifle more water than the run-off as determined. In making such table I generally use a value of N=0.012 in Kutter's formula for the best grades of drain tile, clay or concrete. Many engineers say that this value is to low, but my observation is that the assumption works out all right in a practical way, and the tile drains designed upon this basis have proved satisfactory.

The principal soil tests the drainage engineer cares for relate to pore space, fineness of soil particles, voids, or water-holding space, and not so much the chemical composition. The soils which give up their waters most freely are those containing large percentages of organic matter, with large pore space, but they do not necessarily contain the greatest percentage of water. There is always left, even with thorough tile drainage, quite a large percentage of water in soils where tile-drainage is required, and it is not the function of tile-drainage to remove all, but only the surplus water from the soil, or that which is injurious to plant growth.

Soils—Muck soils and gumbo, such as are found in the American bottoms, along both sides of the Mississippi River in Illinois and adjacent to us, and such as are rather generally found along the lower stretches of the Illinois River, have all responded to tile-drainage. It was not as rapid nor as effective, at first, as the tile-drainage of the wet prairie lands in central Illinois, but after a few years the drains laid in muck and gumbo soils serve their purpose.

Many difficulties have been encountered by reason of an unstable soil at or near the grade line of the drains, and in a few instances drainage projects were abandoned by reason of such difficulties. There is probably not one of these places that could not have been surmounted by a skillful engineer. The "bottomless pits" do not usually extend far in any direction and they may be bridged over by driving piles, crib-work, grillage, or some such method, and laying the tiles on top of planks fastened to the piles or crib-work. It may be best in some instances to cement the joints or use sewer pipe and make cement joints, lay the tiles in a bed of cement grout, or any of a dozen methods which any ingenious engineer may devise. Frequently the source of the excess water, as in the case of spring holes, may be tapped by a lateral or other drain, and when the excess water is prevented from reaching the "bottomless pit" or sink-hole, it will gradually dry up, and admit of easy construction of the drain through it.

Where much fine sand or silt is encountered at or near grade of tile-drain it is desirable to exclude it. Wrapping the joints with jute, burlap, or any kind of cloth, straw or hay is frequently very effective. Getting rid of the excess water by the method before described may also be a necessary part of the operation. The working end of the drain during construction should be kept free of water, and this may require the use of a trench pump.

Bulkheads or Outlets—Too often the outlet is neglected, the money having been expended in tile and labor. In rare instances it is not possible to find a water-course or depression deep enough, within a reasonable distance, to provide a clear outlet, and I have in a number of instances built a well of bricks, laid up in cement mortar, at outlet of tiles, dropped the grade of tile sufficiently to keep it well covered, as much as three feet if need be, and let the water rise in the well to surface of ditch and flow away, using a grated iron catch basin frame and cover at top of well. This method destroys from 20 to 30 per cent of the effectiveness of the drain, dpending upon the height to which the water must rise above the hydraulic grade-line of the tile-drain. It is a last resource, and ought not be employed where possible to secure a good free outlet otherwise.

The ideal outlet is into a small water course which does not overflow its bank greatly, but this is not always obtainable. The tile-drain should be pointed somewhat downstream with the creek and be located where bank is rather high. The general plan may be a V-shaped wall or a straight face with two wings, a segment of a circle, or an L, depending upon the particular location of the work. It should especially extend as deep as bed of stream and be made massive enough to insure stability; the wings extending back into the solid earth banks to insure stability against toppling over. The tile pipe should be well cemented to the wall and have a grate over the end to exclude muskrats and other vermine. These grates are frequently made by drilling holes through the periphery of the tiles, about 2 in. apart on centers, and inserting iron bars 3-8 to ½ in diameter. There are patented gates and other devices upon the market, but none of them seem better or last longer than the iron rods, which can be replaced when they rust out.

Just below the tile outlet, joined to the base of the wall, an apron or platform should be provided to prevent the water from undermining the wall as it emerges from the tile. Where drop is considerable this apron should extend several feet and may require being a foot in depth, never less than 6 in. thick. In several instances quite elaborate watering places for cattle have been made by paving the bed of the stream and making a large trough shaped basin instead of such apron, out of concrete. I usually require a 1:2:3 mix in such concrete work, with no reinforcement, and the work is frequently done by common labor. Supervision is not always possible, and a few failures have occurred, due to not following the plans, the most usual deficiency being failure to go down to the depth required, because of the large amount of pumping to prevent the cement from being washed out of the concrete.

ACCURACY AND COST OF SURVEYS

BY EDMUND T. PERKINS

The required degree of accuracy with which any survey should be made depends upon the purpose or the type of construction for which it is to serve. In making any survey the engineer has a two fold duty. The duty to his client and the duty to himself and his profession. The survey should obtain all the data necessary to insure to the client the most economical and effective design for the proposed work. More than this is a waste of the client's money, less than this is a neglect of the client's interests.

In surveys for land drainage and reclamation most district commissioners, and many engineers, underestimate the practical value of sufficiently comprehensive surveys. The commissioners may think they have secured cheap engineering when as a matter of fact they have only secured cheap surveying at the cost of expensive construction. It is the engineer's duty to point this out to his client. A survey for land drainage purposes should be very complete, but not necessarily precise. Generally speaking a survey for drainage is required which will suffice for a map on a scale of 500 or 600 ft. to the inch and which indicates contours, in the flat lands, at one-foot intervals. In the location of drainage ditches it is a mistake to depend upon the eye or to assume that the open water areas represent the lowest land areas. For example—take a mile of ditch with a 12 ft. base and 9 ft. cut. A possible relocation on ground averaging one foot lower in elevation will reduce the cost of construction by about $1,000, an amount which would warrant the cost of surveying nearly 5,000 acres.

The survey should also locate, for construction purposes, the extent and character of timber areas. Soil survey analysis and its mapping is beginning to be more appreciated. It is a financial fundamental of drainage engineering and it may determine whether the scheme should be carried out at all.

The survey and map is of great financial importance when it comes to spreading the assessments in drainage districts for benefits and damages. This applies not only to the necessary accurate location of property lines and acreages on the plan but also to the relative elevation of property, as a just method of assessment depends more upon the relative elevation of the land than upon any other factor.

There are two principal methods of making a topographic map, the stadia method and the plane table method. The stadia method is the most commonly known. I prefer the plane table method because with properly trained men it will give more accurate results in more detail at less cost. The plane table is like sketching a picture from nature. The stadia method more like drawing a picture in the studio from memory. Fewer shots are required in plane table work because much more intervening county can be truly sketched in when the objects are before the observer. In using a map for

assessment purposes it is convenient to shade it with different colors representing the different elevations. This will clearly illustrate to the court and the appraisers the depth and frequency of normal overflows.

Cost of surveys and maps for drainage districts depends upon the topography, amount of timbered and submerged areas and upon the experience of the engineer in drainage construction work. It will run at the present time, from 17c to 40c an acre. The experienced engineer may be able to get along with less detailed surveys and may even omit some territory. This leads to my second point, the duty of the engineer to himself and his professional brethren. It is the engineer's duty to himself to secure compensation adequate for efficient service to his client. It is his duty to educate his client to appreciate the worth of such services and to resist the temptation of accepting and performing a half way job at a half price fee. If the experienced engineer can really design the work with less extensive surveys he should not trim his fee accordingly. On the other hand he should secure the additional emolument he is entitled to by virtue of his skill.

The position of the consulting engineer in relation to the local practicing engineer is often misunderstood by the latter. As a rule the local practicing engineer must be a man fairly proficient in many lines: paving, sewerage, drainage, structural work or surveying. His practice seldom warrants his becoming a specialist. On large work, involving a considerable expenditure, the services of the consulting engineer should be secured to check up, aid and cooperate with the local engineer. The consulting engineer's service is also an aid in financing and disposing of drainage lands. The common sense business ability of average drainage commissioners is sufficient to realize this and the more important drainage districts allow their local engineer to engage the services of the consulting engineer. There is occasionally a tendency for those in official position to unduly expand governmental functions in technical matters. Public service in engineering should be confined to preliminary and advisory work.

We have too much cut-throat, underbidding competition among practicing engineers. In the procedure for the sale of engineering service let us abandon the public criticizing of our engineer competitors. I heard of one of these occasions where the drainage commissioners received proposals for engineering service. Each engineer in his turn addressed the commissioners extolling his virtues, but more particularly pointed out the shortcomings of the other engineers. The last engineer addressed the commissioners as follows: "Gentlemen, as each one of my predecessors have proved conclusively to you that every one else is incompetent, I submit that there is no one now qualified for the job but me."

WHAT IS A PERMANENT MONUMENT

BY W. D. JONES

The Illinois Statute (Chapter 109) says, "Reference shall also be made upon the plat to some known and permanent monument from which future surveys may be made, or, if no such monument shall exist within convenient distance, the surveyor shall plant, and fix in such manner that the same shall not be moved by frost, a good and sufficient stone and designate upon the plat the point where the same may be found." This does not provide that the stone shall not move by settlement on account of a sewer or tunnel being constructed under it or of a ditch being dug near it or on account of the pressure of some heavy building which may be erected near it. The statute does say (Chapter 38) that "Whoever wilfully and maliciously injures or removes any monument erected, or tree marked as a boundary of any land, or as a state, county, city, town or village boundary shall be confined in the county jail not exceeding one year, and fined not exceeding $100."

Authorities have ruled that the statute must be taken literally to mean a stone, and that a steel rail or a copper rod set in a block of concrete will not do. So we must set a stone, and in time, especially if there are ever any extensive improvements made near said stone, it is almost certain to move. The statute (Chapter 133, Act of 1901) provides that:

> "Whenever the owners of adjacent tracts of land shall desire to establish *permanently* the lines and corners between them, they may enter into a written agreement to employ and abide by the survey of some surveyor, and after said survey is completed, a plat thereof with a description of all corners and lines plainly marked thereon, together with the written agreement of the parties, shall be recorded in the recorder's office. The lines and corners of said survey shall be binding upon the parties entering into said agreement and shall never be changed."

No doubt the boundaries are thus permanently established. Certainly two adjoining property owners can agree that their boundary line shall be as established by a certain survey and shall never be changed. And as time goes on they and their successors can proceed to lose all knowledge of where the line is, in the same way that they lost the knowledge of where it was before they made the last agreement. It was the law that the line should never be changed from the time when the line was first created, and it never was changed unless it was changed when this last agreement was made, and then only if the survey, upon which said agreement was made, was in error. Property lines do not change.

A monument is anything that tells an owner or his land surveyor where his line is. A monument may be a stake, even a fence, or it may be a 20-story building with foundations extending 100 ft. to rock. The building is the most permanent monument, but the time will come when even the building will be removed. Monuments have been moving and being moved and removed from the beginning of property lines till now. Sometimes the monu-

ments are moved and removed wilfully and maliciously but more often carelessly or from necessity that the world may progress. Almost always before any great damage is done by the movement or removal of a monument, new witness monuments have been set, so that the land surveyor is able to tell with certainty where the old monument was.

Sometimes the witness monuments move and move in different directions and the line and corner monument has been reset and that moves in a different direction from any of the witness monuments. It is then that our knowledge becomes uncertain and land surveyors disagree. It becomes a difficult question to prove where the line is. The question, however, is all a matter of proof. You cannot solve it any other way than by proving it. Let us not think that the records of our work are the only things that are of importance to the world.

If a stone monument at a section corner is removed by the digging of a sewer and the stone is replaced at the corner after the back filling is completed it will settle away from the corner. If there is a brick building standing—say— 33 ft. north and 33 ft east of the corner, it will be easy to prove that the said stone which was replaced at the section corner has moved from the corner and how much it has moved. We could have built a monument with a foundation below the bottom of the sewer, but would that have been worth while? Even then a tunnel might be constructed below the sewer and the monument and both would move.

If a section corner monument has been witnessed and removed or covered by the construction of a concrete road and a cross is cut in the concrete surface of the road after the road is completed, the witness corner monuments, if substantial, will be the best evidence of the location of the section corner, for the concrete surface of the road will expand and move the cross. Land surveyors cut notches in cement walks and the walks expand and move the notches. Buildings are the most substantial monuments but even buildings move and are torn down. At the Bloomington meeting in 1919 Mr. M. L. Greeley showed that sometimes buildings even expand.

If there is such a thing as a permanent monument it might perhaps be defined as the monument about which no man has any knowledge that it has ever moved. Such a monument has been permanent up to such time, and just the minute that some one can prove that it has moved it has not been permanent. The permanency has been transformed to the monument or monuments which helped some land surveyors to prove that the old monument has moved. The Supreme Court of Illinois has decided—"That at all Government section corners permanent monuments exist." That is a good decision, but it must not be taken too literally.

PRESERVATION OF SECTION CORNERS UNDER HIGHWAY PAVEMENTS

BY B. H. SUHR

In making a survey in the southern part of Cook County, two corners of the section had been covered with a concrete pavement, and no points had been left to show where the monuments were. This necessitated considerable work on my part, and still left doubt as to whether the new points which I established by theory were where the original corners had been. The Cook County Surveyors' Association took up the matter of replacing section and quarter section corners where new highway pavements were to be built, and a committee was appointed to take this matter up with Mr. Quinlan, Supt. of Highways for Cook County.

Mr. Quinlan said he had put considerable thought on the matter of perpetuating corners coming under pavements, and that his department, together with the contractor on the work, had perpetuated all corners which appeared after the necessary grading had been done. He said further that he had now changed this system, and was instructing the county surveyor to perpetuate all section and quarter section corners falling within the highway. At the suggestion of the committee he consented (1) to have the corners located; (2) to have an iron rod placed to grade where the original monuments were; (3) to have the surveyor who relocated the corners furnish a plat, showing the corner or corners found, together with witnesses; (4) to have said plat recorded in the recorder's office.

A diligent search for corners is seldom made when these corners are covered with several feet of macadam or dirt road. The contractor and his superintendent should not be entrusted with replacing corners, as care is not always taken in replacing corners where they originally existed.

THE PERPETUATION OF MONUMENTS

BY P. E. KOLLEHNER

Under the law all original monuments that can be identified as such must be recognized as the true corners, whether right or wrong, and cannot be changed. Now that agricultural lands and other property are ever increasing in value it is time that something was done to perpetuate monuments and markers. Of course all improvements are referenced or tied into established markers, but the original markers in towns and rural districts are usually in a deplorable condition. How are we to relocate such property?

At every county seat, village, town and city, there should be established astronomical observations for a true meridian, permanently marked with a copper bolt incased in concrete, monuments to be 500 or 600 ft. apart, set not less than 5 ft. deep so that frost cannot heave them. Also every county seat should be compelled to

have a standard measure so that all surveyors and engineers can compare their chains whenever necessity requires.

The county authorities should have power to perpetuate existing established monuments and establish those which are destroyed, the property owner and the county each to take care of their proportional share of the expense. All measurements should be made by chainmen trained for this work and sworn in to faithfully do their duty. These men to be retained by the county and paid a reasonable fee. This would do away with starting out new men on every survey. Instrument observations should be taken to check the measurements.

Where the system of the U. S. triangulation has been complete these stations and the triangulation system lend themselves exceptionally well as perpetuators and reference marks for the U. S. land surveys. Markers should be made of indestructible rust-resisting material either of metal or concrete. The writer thinks very well of an old stovepipe joint filled with good concrete and sunken center or centered with a copper or some other rust-resisting bolt. Another way is to set a rust-resisting cap in concrete, stamped with name of survey, date and title and part of section. These markers to be held by the proper county authorities and sold to the parties requiring them at cost.

Laws should be enacted compelling villages and towns to re-establish all their boundaries and monuments, the expense to be equally shared by the property owner and the county. The grades of all streets should be taken and those of alleys which may prove valuable in future improvements. Each county and incorporated city should be compelled to keep a standard form for plats, profiles and records. For cities, the law should give those in authority the power to re-establish all monuments and boundaries to be made by assessment or some other lawful approved manner. In all cases transit angles must be given, both interior and exterior, as these can never vary.

ACTIVATED-SLUDGE STUDIES AT GRAND RAPIDS, MICH

BY MILTON P. ADAMS
Engineer, Department of Public Works

The experimental sewage work which has been carried on at Grand Rapids has been an intensive operating study of a life-size sedimentation unit. Our problem is one of plain sedimentation and sludge disposal, in order to meet a State supreme court decision rendered in 1913 and requiring the removal of sludge-forming materials from the sewage before its discharge into the local watercourse. The city has the combined system of sewerage, with a normal dry-weather flow of 30,000,000 gals. daily. From June, 1919, to March, 1920, the experimental station was operated with the 32-ft. diameter tank as a Dortmund unit. In April, 1920, this

was converted into a Dorr sewage clarifier and operated until November, 1920, when the plant was closed for the winter.

From experiments with the Dortmund tank, we determined that 57 degrees was very close to the limiting slope which could be used and not allow lodgement of the sludge on the tank bottom. The 45 degree slope was never satisfactory even with squeegeeing to bring the sludge to the tank sump. If sludge was allowed to accumulate in the tank for more than ten days in warm weather, ''tank boiling'' invariably occured. Masses of sludge would be buoyed upward by entrained gas which would escape at the surface. At times the action became general over the surface of the tank, so that the effluent and tank efficiency suffered severely. But the drawing of sludge would generally relieve this situation.

The Dorr apparatus consists of a central vertical shaft to the bottom of which is keyed a 4-way spider having radial arms conforming to the slope of the tank bottom, 1 3-4 on 12. A series of parallel squeegees are set at an angle of 45 degrees with the line of each arm and are so adjusted as to just brush the tank bottom when the mechanism is rotated. A steel watertight cylindrical wall, 4 ft. diameter, was fastened to and supported by the four arms, turning as a unit with the shaft. This original sludge well had a clearence of 5 to 6 in. from the tank bottom and extended about 12 in. above the sewage surface in the tank. The rotation of the arms was designed to roll the sludge over by the squeegees and finally to bring it within the central sludge well. A stationary circular galvanized iron jacket surrounding the sludge well received the raw sewage from the surface inlet trough. The jacket was 6 ft. diameter and 6 ft deep, releasing the sewage in the tank 5 ft. below the sewage surface. The effluent was drawn off by a series of V-notch weirs set around the periphery of the tank.

Operation was commenced May 15, and after June 1 sludge was pumped every 2 or 3 days until the middle of June when it became so concentrated that the pump would not handle it. A mechanical sludge conveyor was devised, driven from the same countershaft which drove the clarifier. The sludge was removed from the surface of the well by a chain of quart buckets and elevated to a tray from which it slid into a horizontal flight conveyor running in a wood trough. At the end of the trough the sludge dropped down a chute into a loading hopper, from which it was wheeled to the beds and spread out to dry. The wheelbarrows were calibrated so that the amount of sludge removed could be recorded.

During a period of ten days in June, there was no movement of sludge into the well, that portion of sludge at the bottom and around the entry to the well having concentrated to such an extent, that after the conveyor was put into operation, about 40 cubic feet of sludge were all that could be withdrawn. The black, sulphurous liquor remaining in the well could not be removed fast enough to force more sludge in. Pumping of sewage was stopped and the tank

was drained July 1. After removing most of the sludge on the tank bottom it was discovered that an island of sludge had formed about the well which had been rotating as a unit with the mechanism. The entry to the sludge well was practically plugged. During May and June, 24,000,000 gallons of sewage were passed through the tank with an average removal of suspended solids of 30 per cent. corresponding to a indicated removal by settling solids determinations of 94 per cent. A total of 1,900 cu. ft. of sludge was produced with an average moisture of 87.8 per cent.

The sludge well was then constructed as a truncated cone of galvanized iron 10½ ft. high with a diameter of 11 ft. at bottom and 4 ft. at top. The change increased the sludge well storage from 1,400 to 5,000 gals., and increased the area of sludge opening.

Operation was resumed from July 30 to Nov. 21. The first sludge was removed from the well on Aug. 24, and was scum sludge, removed for the most part above the water surface in the tank. It was the dryest that we had obtained, 67.5 per cent. All of the surface sludge had been removed by Aug. 31, several feet of black sludge liquor appearing at the top of the well. This liquor was pumped back to the incoming sewage. About 4,500 gals. of liquor were removed from the well at this pumping which allowed the well to completely fill with sludge from the tank bottom. Havoc was generally played with the tank effluent when this liquor or soft sludge was returned to the sewage inlet. The effluent cones would be darker than the raw sewage cones for several hours. The suspended solids and turbidities also ran much higher at those times than in the raw sewage, although the settling solids were not appreciably affected.

It is planned to reopen the station in the spring, applying the clarifier to a still shallower tank, reduce the sludge opening into the present well, and develop an underflow sludge delivery from the bottom of the tank. The sewage and liquor inlet to the tank will also be revised. From August to November, 48,200,000 gals. of sewage were treated in the clarifier, 2,311 cu. ft. of sludge averaging 83.2 per cent. moisture were produced.

"Pin-point boiling" is a special feature of operation of the clarifier, caused by the bursting of minute gas bubbles at the surface. This gas is evolved in the sludge on the tank bottom and released by the periodical moving of squeegee arms through the sludge. The action is identical with "tank-boiling" experienced in the Dortmund tank. On shutting down for a few days in June, a 6 in. leathery scum of sludge formed over the tank surface in 24 hours. This shows the necessity of the operation of some kind of agitator for promoting good sedimentation in a tank of the type.

Tiny globules of oil generally accompany these fine gas bubbles to the surface, this iridescent coloring of oil on water which being the only visible effects of this action. Half of the tank was baffled during the last three months of operation, the oil being caught just

before passing out over the outlet weirs. As a result the effluent from this half of the tank was greatly improved although the appearance of the baffled half of the tank was accordingly sacrificed by the collection of the thin layer of scum retained upon it. It could not be proved that this "pin-point boiling" decreased the efficiency of sedimentation.

Sludge—The 80 per cent. sludge produced during 1920 was a fairly stiff semi-solid and dried much less readily on the beds than the 94 per cent. of 1919. The original Dortmund tank went into operation June 30, 1919. On July 25, the first sludge was drawn through the sump outlet and delivered to a secondary tank. Its tarry odor, brownish-black color, and curdy consistency were at once evident. Moisture determination ran 94 per cent. On Aug 7, about 300 gallons of this sludge were allowed to run directly to the sludge beds from the primary tank, and 18 days later this same sludge was removed from the beds in pieces as a matted, porous fibrous cake. After a few days further drying, this sludge was burned in piles, leaving a fluffy, reddish ash. Contrary to the behavior of most sludges, which fissure vertically in drying, this sludge seemed to dry in layers, separating laterally. This very unusual behavior of a practically raw sewage sludge drying on sand beds under all sorts of weather conditions without nuisance of even appreciable odor, caused us to dispense entirely with secondary tank digestion during the past year.

Since we had precisely the same sludge experience in 1920 as in 1919 and one that differs so radically from that in other cities, we have attempted to explain the mystery by a combination of circumstances. 1. We have a sewage that is comparatively dilute, amounting to more than twice the average water consumption. Thus the medium is provided by which many of the finely divided organic solids can be carried off in the effluent. 2. The presence of tarry oils has always been noticed in the sludge. These are discharged in alleged small amounts by the local gas works. The antiseptic action of these light oils has long been recognized. 3. A large proportion of the sludge is made up of pulpy rag and strawboard wastes. This material is practically inert and forms the fibrous mat which facilitates the drying and burning of the sludge. Samples of this dry sludge had a heat value of 7,000 B. T. U.

The ability of the sludge to "set up" when it is not periodically agitated was again manifested in October, 1920. Instead of forming at the bottom of the well as before, several yards of the sludge formed a huge plug within the flare well. This was broken up only after decanting off the upper 10 ft. of sewage, which allowed the plug to drop down within the well and spread over the tank bottom. A hose stream helped in breaking up the mass.

From the Grand Rapids standpoint, with a sludge promising so little difficulty to handle, the high concentration is very desirable, especially where an almost unlimited space for sludge beds

can be provided. There are 130 acres in the tract selected for the site of the permanent plant—fairly well isolated from the city. The Dorr clarifier has given practically the same sedimentation efficiency as the Dortmund tank and delivered a much more concentrated sludge for at least six months. A strong point is the concentrating effect due to the rotation of the arms through the sludge. Against these advantages are the greater depreciation in Dorr superstructure and mechanism and the greater expert attention required for the successful operation of a plant of this type, but it is difficult to imagine a plant the size of the future Grand Rapids plant without a competent operating staff. Hoad & Decker were the designers of the original Dortmund tank and testing station. The Dorr Co. has cooperated with the city in conducting its experiments during the past six months. Analyses of samples were made under the supervision of the chief chemist, Walter A. Sperry.

FUTURE OF THE ILLINOIS STATE PUBLIC UTILITIES COMMISSION

BY W. R. GELSTON

Many cities have attempted the operation of municipal water and gas plants, primarily for fire protection and street lighting purposes. They did not usually make any consistent effort toward the development of the commercial side of the business and many of the early municipal plants were eventually purchased by private interests. By careful management the corporations were soon able to furnish better service than the cities had furnished and still make a reasonable profit for their stockholders. The apparent failure of municipal ownership and the success of private ownership opened up a large field for the investment of private capital and the capitalist took advantage of the opportunity.

With the success of his venture assured, the capitalist in many instances, became arrogant. He injected himself into politics, seeking concessions and favors for his company. The dishonest public official soon realized the latent possibilities of his own gain, in the public service corporation, and he developed his system of corporation baiting. City councils passed rate fixing ordinances, reducing rates, and in some cases repudiating rates already established in unexpired contracts. Frequently such new rates were confiscatory and they were usually adopted without consideration of the cost of supplying the service and without expert advice. In such cases, the only resource left to the utility company was a compromise rate, which might be secured by the judicious use of money, or an appeal to the courts which resulted in expensive litigation for both the city and the company.

Realizing the desirability of having a disinterested board of experts for the arbitration of disputes between municipalities

and service corporations, Massachusetts established the first state public utilities commission in 1885. Two years later, the Interstate Commerce Commission was organized by the U. S. Government. The powers of both of these commissions were very limited at first, but as public confidence in them increased they were given additional authority. The results of these first experiments were so successful that in 1905 Wisconsin adopted a public utility commission law which was very similar to the Interstate Commerce Commission law. Then New York adopted a commission law in 1907, California in 1911, Pennsylvania, Indiana and Illinois in 1913. By 1916, Utah was the only state which did not have a commission for the regulation of public utilities.

There is a great difference in the extent of the powers vested in the various state commissions but practically all of them have authority to fix the rates charged for service by utilities corporations. At least two of the states, Wisconsin and New York, gave their commissions authority in the regulation of utilities owned by municipalities. It is not claimed that perfection has been secured. The appointment of commissioners in many states has been tainted with politics. Many of the commissioners have regarded themselves as protectors of the public interest rather than as impartial judges. But, in spite of faults and failures and partisan criticism, it must be conceded that commission regulation has brought about a very marked change in the attitude of the public service corporation official toward the general public. It has established precedents which are generally followed in appraisal work. It has standardized methods of accounting and apportioning rates to various classes of service, especially in the water works and electric fields. In fact, commission regulation has placed the public service business upon a higher plane. It has made the business safer, though perhaps not so lucrative, for the corporation and has generally improved the character of the service for the public.

There is now a movement in Illinois for the repeal of the Illinois Public Utilities Commission law, the commission being then abolished and ''home rule'' restored to the cities. The new Governor has declared himself in favor of the repeal. This opposition to the Utilities Commission grew out of the conditions brought about by the war. Before commodity prices began to rise as a result of our participation in the war, the Illinois Utilities Commission had been reducing the rates charged by public service corporations. This, of course, met with universal public approval and most of the corporations affected by the decision were satisfied with commission regulation because they felt more secure in their relations with the public on account of the elimination of the city council menace which had previously been the bane of their existence. City councils considered it entirely proper to invite the Commission to come and revise rates downward, even when unexpired rate con-

tracts with their utilities were still in force.

When the high cost of living hit the public utilities the Illinois Commission found itself confronted with the necessity of increased rates, for public service. It braved the storm of political and public disproval, assumed its proper judicial function and granted relief where relief was needed. Fair minded men generally realized the necessity of upward revision. They wanted good public utility service and expected to pay a fair price for it. The professional politician, on the other hand, immediately seized upon the opportunity to make a grand stand play before his constituents.

While the Illinois Commission is still increasing some rates in spite of the fact that commodity prices generally are slowly declining, it is also true that some of the cities are increasing the rates charged by municipal plants. The crest of high utility rates has, perhaps, not been reached but it will be soon and then the process of reducing rates for utility service must be accomplished. If the State Utilities Commission has supervision of the reduction process, it will probably be brought about gradually, in a systematic manner and with very little friction. The utilities companies will generally respect the orders of the Commission and obey them because they will know that the orders of the Commission are based upon facts, figures and expert experience. If, on the other hand, "home rule" is restored to the city governments, rate reduction will be attempted by the passage of arbitrary rate fixing ordinances which, in many instances, will be confiscatory and can only result in tedious and expensive litigation. The consumers of the public utility service will have to pay all of the costs of the litigation regardless of which side gets the judicial decision.

FINANCING MUNICIPAL WATER SUPPLIES

BY W. D. P. WARREN

In the State of Illinois are twelve cities with more than 2000 population and more than 600 cities and villages of less than 2000 population without a public water supply. A supply of water satisfactory both as to quality and quantity should be possessed by each city having a population over 1000 and by many smaller cities where the supply may be secured without great cost. During the past few years few supplies have been installed and extensions to existing supplies to meet increasing demands have in many places been inadequate. The past year was dry and conditions were especially bad in many cities depending upon surface and shallow ground water supplies. With the cost of materials high and the bonding capacity of many cities insufficient to meet the expense of proper improvements, the situation has developed to a point where immediate relief should be provided, otherwise dangerous sanitary conditions will be created and the growth of industrial life greatly retarded.

A few typical cities may be noted. Gillespie has a population of approximately 5,000 and is without any water works system. It has paved streets, electric lights and sewers, and is in the center of an immense coal field with mines and railroads as possible water consumers. . The estimated cost of the supply system, independent of the distribution system is $150,000, while the bonding capacity at the present time is only slightly above $20,000. Virden, with a population of 4,700 has delayed the construction of sewers pending the development of a water supply. A reservoir proposition has been recommended which will probably cost at least $125,000, which is $75,000 in excess of the bonding capacity.

An examination of conditions at many plants discloses the fact that the supply is of poor quality and unsuited to domestic uses, that modern filter plant or water treatment plants are greatly needed, and that often the supply is such as to limit the free use of water for the purposes to which it should be liberally supplied. It is true that a number of cities have overcome such situations, through the co-operation of public-spirited citizens, and it is greatly to be regretted that such co-operation has not been more general. Among a few of the cities which have realized the situation and have set about to remedy it are Decatur, Hillsboro, Casey, Pana, Jacksonville and Quincy. The plan of securing an adequate water supply in such cities has been brought about generally by a willingness on the part of local parties to invest in the securities of the water supply company formed for the purpose, or to assume responsibility otherwise for the payment of funds necessary to construct the improvement. The plan at Jacksonville was essentially as follows, as abstracted from the report:

"Your city council, in conjunction with the Citizens' Committee, have prepared ways and means to proceed with this undertaking and have prepared the system of finance for the construction of the same and the liquidation of the liabilities. Your joint water committee when they acquire the deed to the State property, have accomplished practically all they can do until this proposition is financed. In order to finance the 380 acres of land necessary, the citizens of Jacksonville must organize an individual group or a corporate company to finance and purchase the 380 acres of land and then consummate a lease and option with the city of Jacksonville, for the said 380 acres of land for a term of 20 years, under such arrangements by contract and ordinance as are necessary and required to properly secure the contract to both parties."

At Hillsboro, the plan was carried through in such manner that the city secured an $80,000 improvement with only about $8,000 available from bond issue. A part of the cost of the 14-inch cast iron supply main, and the 300 acres of land necessary for the impounding reservoir was financed by optional contract. The citizens executed notes running five years, for $100 and $200 each, to a trustee, who held title to a part of the land purchased, and

who gave his notes as trustee to banks, putting up the citizens' notes as collateral. The city pays interest and at least $1,000 annually on principal.

Decatur is now constructing a water impounding project which will cost approximately $2,000,000, at least $1,000,000 of which will be raised by means other than a bond issue. The following is an extract from the report of the attorney appointed by the banks of Decatur, working with Mr. Ralph J. Monroe, corporation counsel:

"Since the city does have power to enter into contracts for the purpose mentioned if such contracts do not conflict with the provisions of law referred to, we would suggest that a water supply company be incorporated under the Illinois law to acquire the lands to be flooded and to furnish the money to alter roads, raise bridges, etc., with which the city will enter into a contract in the nature of a joint undertaking to furnish water to the city of Decatur and to its citizens and industries. The city will complete and furnish its new dam, its existing pumping plant, water mains, etc., and the intakes, and the water company will acquire and furnish the lands to be flooded and the capital with which to alter the roads, raise the bridges, etc. The city will pump water through its mains and furnish it to the inhabitants and industries, and for fire protection, etc. The city will fix the rates, not for the benefit of itself alone but for the benefit of both the city and the water company. Such funds will be collected for the join account of both parties. Out of such joint account shall be paid to the city first a sum sufficient to cover the operating expenses of the water system exclusive of dam maintenance, depreciation, betterments and further capital expenditures. The remainder of the joint fund shall be paid one part to the city and the other part to the water company, the proposed proportion being half and half but the exact amount to be left open until further calculations are received by your committee. No charge is to be made to the city for such water as it pumps from the reservoir for public use.

The contract will contain provisions looking toward its cancellation by the water company if it does not receive from its share of the joint fund each year a sum sufficient to pay a fixed return to its stockholders, or the contract is held illegal or the payment of the moneys to be received by the company under it is enjoined. In any of such cases, however, the water company in consideration of the payment to it of certain sums which the city is now able to pay without increasing its indebtedness undertakes to acquire the lands to be flooded and to furnish the capital to alter the roads, raise the bridges, etc., and gives to the city the option to take water from the reservoir, flood the lands of the water company and obtain the benefits generally of the undertaking on the payment in advance for successive periods of thirty days each of eight cents a thousand gallons for all water pumped during the preceding month.

In the event the joint undertaking is terminated by action of the water company or otherwise and the option just spoken of not exercised, or if having once been exercised such option is not renewed, the city will be required to open its flood gates and remove such of the dam as will impede the flow of the water and keep it at any level above the level under present conditions and in default of the city's taking such action the water company will be empowered to take it. In this way, altogether aside from any considerations of legal security, the water company will have the practical security after

having made its investment, that the city cannot get any benefit from its dam now under construction nor obtain an adequate supply of water without exercising and renewing from time to time the option contained in the contract.

It is estimated that as much as $1,000,000 may be required by the water company to acquire lands, alter roads, construct bridges, etc. We would suggest therefore, the organization of a water company with a nominal amount of no-par value stock and $1,000,000 of retirable par value stock. Sufficient of the no-par value stock could be subscribed immediately and paid for at as little as $5 a share to bring the corporation into being. Thereafter the retirable par value stock could be sold in the community. It should be retirable only when its par value and 7% per annum upon such par value to the date of its retirement (less any dividends paid) shall have been received. Out of the income to be derived from the undertaking dividends can be paid upon the retirable stock and it can ultimately be retired. When it is all retired the few stockholders who are left who hold no-par value stock can cause the water company to convey its entire property to the city and wind up the corporation."

It is evident therefore that a plan can be found to finance an additional water supply, provided the importance of the step is sufficiently felt by the citizens of the community. Attention is directed to the necessity of providing a means whereby the average city can more readily finance an adequate water supply. Legislation is needed which will permit cities to finance such projects with less complicated methods. In this connection we submit a letter from Ralph J. Monroe, corporation counsel for Decatur, who has given this subject much study and his experience in developing the plan for Decatur renders his opinion very valuable.

1. By statute in 1899 the State authorized the construction or purchase of a water plant by a city and the issuance of water certificates bearing interest and secured by mortgage on the property constructed or purchased and payable out of the income of the property and from no other source. This statute in itself is constitutional, but the difficulty arises, as pointed out in Joliet vs. Alexander, in those cities which already have a water plant and desire to procure money for additional improvements, in which event it is always a legal impossibility to devise any proper division of income which can be allotted part to the old plant and part to the new. As any scheme which pledges existing income of the city violates the constitutional inhibition, it can readily be seen that this form of financing is not satisfactory except in cities which have no plant at all to begin with, in which last named cases the scheme is very desirable and practicable, although the private water company plan of financing has some advantages over it as I will later point out.

2. All other schemes of financing municipal water supplies where the city is up to its debt limit or near it depend upon private capital; some of the common forms being: (1) Organization of a water supply company to construct and operate the plant; (b) Trustees to sell trustee certificates, purchase the property and lease it to the city; (c) Contract with the construction company to build the plant and sell it to the city on a conditional sales contract.

The first of these three is very desirable where it can be used. It has its advantages over the municipal water certificates first mentioned in that the corporation will hold the title to the property until paid for and has the advantage that no foreclosure would be

required. At Decatur we are using this form of organization to procure the land, change roads and bridges and put the reservoir in condition with an added feature of a joint working agreement with the city whereby the city pumps the water, distributes it, fixes the rates, collects the same and holds the money for the joint use of the water supply company and the city with a proviso that the operating expenses of the plant and water system must first be paid out of the proceeds with a further proviso that when the stock of the water company, which is cumulative, shall have been retired the Board of Directors and officers shall convey the property to the city.

This plan also has a second provision in that if the joint operating arrangement shall be held by any court to be illegal, the city shall have the option to lease the reservoir and take water therefrom by payment in advance, first of a lump sum and thereafter in quarterly installments, the amount to be determined on the basis of cents per thousand gallons on the pumpage for the preceding quarter. This last proposition is clearly legal and enforcible and we are satisfied that while the question has never been decided the joint arrangement between the water supply company and the city is sound and cannot be successfully attacked.

The trustee arrangement is the one commonly used and is very satisfactory except that if the investment is sufficiently large, inasmuch as the courts have indicated that the payment payable in any one year is a debt, it might be that that amount payable in any one year might in itself be a violation of the debt limit. This can be avoided by having the quarterly installments payable in advance somewhat after the fashion above outlined.

The plan of letting a construction company build the plant has its advantages in that such an agreement relieves the city administration and citizens from the worry and work in financing. But it will be found upon examination that this relief is dearly paid for, as any contractor knows that his security is not of the best and he has to be well paid for the risk, local communities being much more restive if the security is all held by the contractor rather than by local citizens. Further, the contractor knows that it is a long time investment and figures on discounting the contract through some brokerage or banking firm and the discount is always very heavy. However, as a last resort this plan is better than none."

The various methods of financing as pointed out by Mr. Monroe, should be very valuable to cities desiring to construct water works improvements, where such cities are already indebted for an amount greater than 5% of the assessed valuation. The success of any of the above plans depends upon the spirit of progress and co-operation among the citizens of the community in which it is desired to use the plan. It frequently happens that because of local jealousies or lack of sufficient leadership, it is impossible to carry through any of the plans suggested above, and for cities and villages in which such conditions exist it is extremely desirable that a plan of finance be provided which will enable them to secure the necessary water supply. In June, 1917, the Illinois legislature passed an act to create sanitary districts and to provide for sewage disposal. An act to create water districts, patterned somewhat along similar lines should do much to remedy the situation now existing.

TOPOGRAPHIC AND DRAINAGE INVESTIGATIONS IN ILLINOIS

BY J. H. HANCE,

Assistant Chief of State Geological Survey, Urbana, Ill.

This report is intended as a brief synopsis of the topographic mapping which has been done in Illinois up to January 1921, and of drainage investigations carried on by special State Survey appropriations up to 1919. During the past two years special drainage investigations were carried on along two separate lines; (1) a reconnaissance survey of the State under the immediate charge of Prof. G. W. Pickels, University of Illinois, (2) a study of the legal problems involved by F. B. Leonard and W. G. Hale of the same institution.

Topographic Map Work.—The first topographic mapping in Illinois was done by the U. S. Geological Survey in 1887. Until 1905 the State gave no assistance in this work. In 1905 an agreement was entered into by the State Geological Commission of Illinois and the U. S. Geological Survey whereby each organization was to expend not to exceed $10,000 each year in the topographic mapping program for Illinois. The Federal Survey was to do the work with its organization of trained engineers, and the State reserved the right to determine the areas and order of progress of the work. Annual appropriations ranging from $8,000 to $10,000 have been made by the State for this work since that time up to the last biennium, when the amount was increased to $15,000 per annum.

At the present rate it would take about 35 years to complete the State of Illinois. The Federal Survey has considered increasing its annual budget for this purpose, so as to finish the work in 13 years. On a 13-year program we must average about 2,800 square miles per season. Last season about 780 square miles were mapped and 2,750 miles of traverse and 140 miles of levels were run.

As soon as the area in a county is completed, the State issues a topographic map of that county. Eight such maps are now available: St. Clair, Clinton, Monroe, Gallatin, Hardin, Lawrence, McDonough, and Randolph. With the completion of 8 quadrangles in the southern part of the State, 9 more county maps can be issued; Alexander, Jackson, Johnson, Massac, Pope, Pulaski, Saline, Union, Williamson.

For the valley floors the maps show—dimensions, gradients, tributaries, with their dimensions and gradients, area, slopes and gradients of the watersheds, inter-relations of the streams. This, with the rainfall data enables the engineer to compute the stream duties. Such maps with geologic data on the surficial rocks would enable an engineer and a geologist to make definite plans for a large portion of most drainage problems without additional field work. Problems such as muncipal water supply and sewage dis-

posal are partly answered by such a map. All this in additional to such other problems as highways, power lines, municipal improvements, etc. Without such maps much of the work is done several times by different interests, its costs are capitalized and the people pay the bill. Eventually the topographic map of the State will be completed, and the State will pay for that. A 13-year program for Illinois calls for $35,000 per annum. Can we afford to spend less than this amount, especially in view of the road-building program and drainage projects which must be taken care of in the next decade?

Drainage—The State appropriated $15,000 for studies during the period 1907-1909. A State Committee on Waterways Reclamation was organized including representatives from the State Geological Survey, Internal Improvement Commission, and the U. S. Department of Agriculture. To the State Geological Survey was assigned the making of detailed maps of the river valleys. The original work was done along the Kaskaskia, Big Muddy, and Embarrass rivers. This was followed by other work along the Little Wabash and Sangamon. As a result of the first year's work, it was estimated that over 1,000 miles of valley along some 18 rivers of the State included bottom lands of 2,550 square miles. Of these probably 90 per cent were unprotected from floods. At that time attention was called to the fact that these lands were given to the State on condition that they be drained. Hence the obligation on the State's part.

Appropriations of $7,500 were made to carry on these investigations for each of the bienniums beginning in 1909, 1911, 1913. During this period detailed topographic surveys were completed in the valleys of the following five streams: Big Muddy, Embarrass, Kaskaskia, Spoon, and Pecatonica.

In the ideal system of impounding the flood waters by means of numerous dams on the smaller streams, three great objects may be accomplished: (1) The flood waters may be saved for use during low water stages of the river: (2) Their outflow may be used to generate power; (3) By storing the flood waters and rectifying the river channels the bottom lands may be largely drained and reclaimed.

SPECIAL ASSESSMENTS

BY EDGAR B. TOLMAN,

Lawyer, Chicago

It is my purpose to talk on some of the aspects of local improvements which seem to me of interest to engineers, and particularly to men engaged in municipal engineering enterprises. The origin of the system of special assessments is very interesting. The time came early in the history of taxation when the general tax levied on property was insufficient to meet those new constructions which became a growing need of advanced civilization. Under principles

of justice and common sense, too, it was not fair that all of the community should pay all of the cost of an improvement which, in a special and very large degree, financially benefited a few, in a measure clearly distinguishable from the general benefit to the community at large.

From this condition there sprung up the system of special assessment for local improvements; in which the main inquiries, from a financial point of view, were these: 1—What is the benefit to any particular piece of property that is situated so close to or in such relation to the improvement, that it receives a special benefit which the property of the community at large does not receive? 2—What benefit is there to the general community from this improvement? Then the proportion of benefit between the public and the private property was ascertained, perhaps by percentages, a proportion of the cost equal to the proportion of the benefit to the public was charged to the public as "public benefits," and paid by general taxation, and a proportion of the cost equal to the proportion of the benefit to private property was charged to the particular pieces of property which would be directly appreciated by reason of the construction of the improvement.

The growth of this system of taxation is increasing. We are able to make improvements by special assessment that, 20 or 25 years ago, the courts would not let us make. For instance there has been a great deal of doubt and controversy in the courts as to whether or not a bridge could be built by special assessment. In an early day a bridge which was part of an approach to a street and from one street to another, across intervening railroads, was held to be a local improvement because it was a part of that street improvement. Encouraged by that view, Waukegan, needing a bridge across a ravine and not having the money to build it out of general taxation, levied a special assessment upon all the property in the entire municipality at about an equal rate, in order to pay for this bridge. But the Supreme Court said: "You cannot do that; that is not a local improvement. You are attempting to make an improvement which is of general benefit and generally needed by the entire community, and you are putting the whole community into your taxing district. That is a subterfuge. There are no elements of special benefit in it."

In the great Chicago improvement where Michigan Ave. crosses the river, the question came up as to whether that bridge could be built by special assessment. I had the honor of presenting that question to the Supreme Court, and we went with a good deal of trepidation, because of the Waukegan bridge case. But there were presented to the court the particular features of the Michigan Ave. improvement which distinguished it from others: That this was not merely a bridge, but also a part of the street. The whole scheme of the street improvement could never be carried out with-

out this particular bridge, so that the thing was a unit. Fortunately we got by without being told that we must pay for that bridge by general taxation.

What is a local improvement that can be paid for by special assessment? It seems now to be very clear that the test is this: Is the improvement so related to private property that it produces a direct and immediate enhancement of the market value of private property. Our new hard roads run through cities and the cities have to approach the problem: "This road is only 18 feet wide but through our municipality it ought to be 66 feet. It is only 6½ inches thick and we think that in our place, where there is a lot of truckage, it ought to be 9 inches." How are we going to coordinate it to our own private necessities?

There seem to be two types of solution of that proposition. One is for the municipality to direct, by special assessment, the construction of a road in precisely the kind and the dimensions that it wants; to ignore the existence of any state road whatever and build it all, charge to public benefits a sum of money equal to the cost of that portion of the road that would have been built by the state, and then, by agreement with the road authorities, have that public benefits judgment paid out of the State fund. Some municipalities have carried that plan into effect and have been approved for the banks that have purchased the special assessment bonds. Another way is take it for granted that the State is going to build its road in the usual way and describe in your improvement a pavement on both sides of the strip that the State is to pave, levy your assessment for the cost of that part only, and then by co-ordination of dates get the two jobs done together. Quite likely it may be legitimately arranged that the lowest bidder on the two will be considered the lowest bidder on each.

But the possibilities of trouble are almost infinite when attempts are made to mix these two proceedings together, because the special assessment law does not recognize co-operation with anybody else. The resolution and the ordinance and the estimate must describe an improvement and that particular and precise improvement must be constructed, and no other than that can be paid for out of the special assessment funds.

One subject more, and that is the financing of these special assessment securities. Theoretically special assessment bonds ought to be the best and most desirable securities that we can imagine. They ought to be in very high demand at the banks. About 20 years ago, in Chicago, these securities commanded a premium. The banks liked them, and private investors bought them. Then little things conspired to prevent the payment of these bonds at maturity and the market fell to a very depressing rate. Bankers have this peculiarity: if they buy paper that is due on a certain date they want to be absolutely sure that every particle of that paper, principal and interest, is paid punctually on that date. An assurance

that sooner or later it will be paid, after supplemental proceedings are in and the Supreme Court has decided certain appeals, will not satisfy them.

The one thing that is necessary to keep that paper at the legitimate level is intelligent and faithful attention to the requirements of the law with regard to the methods to be determined in the beginning and carrying on and confirming and collecting the special assessment. In many small communities it is difficult to find men who have had experience enough to know all the requirements of the law, but where there is appreciation of the importance of the work and of entrusting it to people of capacity and not turning it over to incompetents, there is being attained a better degree of accuracy and perfection on the legal side of these proceedings.

Every security has got to depend on more than one factor. In the first place, it has got to be sound economically. In the second place, it has got to be in accordance with the requirements of the law, and, in the third place, it depends on the psychology of the community. There must be a friendly psychology. A hysteria psychology will ruin any security; so that co-operation between public officials and the public is one of the most important features to rehabilitate the market for this useful and valuable type of security.

REPORT OF COMMITTEE ON WATER SUPPLY.

(PUBLIC AGENCIES FROM WHICH INFORMATION RELATIVE TO WATER SUPPLIES MAY BE OBTAINED)

The U. S. Geological Survey investigates water resources. The U. S. Weather Bureau maintains meterological stations at Chicago, Peoria, Springfield and Cairo and on the border of Illinois at Debuque, Iowa, Davenport, Iowa, Keokuk,, Iowa, Hannibal, Mo., St. Louis, Mo,. and Terre Haute, Ind. In addition, there are 81 less complete stations, making 91 stations from which precipitation records may be obtained.

The State Department of Public Works and Buildings has police power to see that streams and lakes are not polluted, investigations of stream pollution being made by the Division of Waterways. This department also measures stream flow in cooperation with the U. S. Geological Survey. The State Department of Public Health acts in advisory capacity relative to public water supplies, water purification works, sewer systems and sewage treatment works; and exercises supervision over nuisances growing out of the operation of water and sewage works. The Division of Engineering investigates and approves plans for new improved water supply and sewer systems, including water purification and sewage treatment works; investigates stream pollution and methods of sewage and industrial waste purification; examines and certifies water supplies for use on common carriers in cooperation with the U. S. Public Health Service; makes surveys with special reference to water supply and sewerage in cooperation with the Division of Surveys and approves plumbing ordinances.

In the Department of Registration and Education, the Natural History Survey Division has investigated the life in, and consequently the quality of water of the Illinois River. The State Geological Survey Division studies annual resources, including water resources, and has on file many logs of wells. During 1920 it published a bulletin on "Artesian Water in Illinois," in cooperation with the State Water Survey Division. This latter division collects and distributes information concerning water resources, determines standards of purity of drinking water, and is studying hydrogen-ion concentration of Illinois waters with reference to its bearing on methods of purification. An experimental sewage treatment plant is being operated. The Division of Fire Prevention of the Department of Trade and Commerce investigates fire hazards and is interested in improvements of water supplies for fire protection. The Public Utilities Commission has supervision of all public utilities, including those operating public water supplies.

Some semi-public agencies interested in water supplies of the State may be noted: The Illinois Inspection Bureau inspects waterworks throughout the state excepting in Cook County, municipalities being placed in ten classes after a study of the water works, fire department, fire ordinaces, types of buildings, congestion, etc. The Chicago Board of Fire Underwriters covers the same field in Cook County. The National Board of Fire Underwriters makes inspections for the Illinois Inspection Bureau in cities of over 20,000 population, and is ready to furnish cities and their engineers with information which it has available.

ROBERT ISHAM RANDOLPH
PRESIDENT
Illinois Society of Engineers
1922

LIST OF ADVERTISERS

MAIN STREET

They've taken out the old town pump, likewise condemned the well,
We're going to get our water from a tap.
They've built a dam across the creek to store the floods that swell
And spill their bounties out of nature's lap.
The water may be muddy, but they're going to filter it,
And kill the germs with stuff they call chlorine.
The engineers, they tell me that I needn't mind a bit,
Because they're going to wash the water clean.

We've got a sewer system now that empties out o' town,
And plumbing things inside the house, as well;
And that ain't all, those engineers have done the thing up brown,
They're even going to 'liminate the smell.
They've built a concrete tank below the reservoir,
To wash the dirty water from the sewer.
They're going to make it cleaner than it ever was before.
It sounds queer, but the engineer is sure.

Ma used to fill the parlor lamp and clean it every day,
It smoked a lot unless she trimmed the wick,
But now we never bother when the daylight fades away,
We get both light and power from the creek.
We wash by electricity, and milk and skim and churn,
Ma even sweeps and cleans with vacu-um;
The chores are all so easy now, there's just a switch to turn,
Those engineers have surely made things hum.

We used to wear our boots whenever we went down the street,
The mud was hub-deep in the Spring and Fall;
But now the pavement is so smooth and everything so neat,
The girls wear hardly anything at all.
They're not so hard to look at, and we're getting used to heaps
Of things our elders didn't used to do.
Those engineers have broadened us and waked us up for keeps,
They always are inventin' something new.

The town ain't hardly big enough to hold their energies,
They're running Main Street way out past the farms,
They've made us better neighbors in these piping times of peace,
Our local pride is stretchin' out its arms.
From Waukegan to Cairo, from Quincy to Danville,
The length and breadth of Main Street measures now.
And I don't want to flatter, but I wouldn't speak him ill,
And I think the engineer has taught us how.
January 13, 1922. ROBERT ISHAM RANDOLPH.

1. **Licensing of Engineers and Surveyors.**—As the State of Illinois has passed a law requiring the licensing of land surveyors in counties with a population of 250,000 or more, and a law for the licensing of structural engineers, and as other states have laws relating to the licensing of engineers and surveyors: Resolved, that it would not be detrimental to the profession or the public if any engineer or surveyor who is registered in another state were allowed to practice in Illinois, while it would be an advantage to the engineers and surveyors of Illinois if registration in other states was less difficult. That a committee should be appointed to take steps to secure for all registered engineers and surveyors in this state registration in other states with the least possible trouble and expense.

2. **Engineers in Executive Positions.**—The Illinois Society of Engineers has consistently advocated the appointment of engineers to executive positions in the administration of public affairs. As the president of the United States has appointed Herbert Hoover, a distinguished engineer, as secretary of the Department of Commerce, this society expresses its confidence in the ability and patriotism of Herbert Hoover and its appreciation of his fitness for this high office.

3. The society expresses its approval of the recent appointment of an engineer to the office of State Superintendent of Highways in Illinois, and commends the governor of the state for this appointment.

4. **Municipal Plumbing Code.**—The Secretary of Commerce of the United States having appointed a committee of engineers to report on the development of standards for a model plumbing code, which is a matter of importance to sanitary engineers, health officers and the public, this society will appoint a committee to cooperate with the Department and its committees and to secure for this state the results of the investigation for consideration in preparing a state plumbing code.

Overlapping of State Bureaus.—There is an apparent overlapping of jurisdiction in the powers conferred by statute on the State Department of Health, the Division of Waterways (Department of Public Works) and the Fish and Game Commission in regard to the supervision of plans of water supply, sewage disposal, stream pollution, waterway and water power development and the drainage of swamp lands. As this causes duplication of executive functions and confusion to the public a committee should be appointed to study the conflicting provisions of the statutes and to recommend their proper division of consolidation.

6. **Revision of the Drainage Laws.**—A report on the revision of the state drainage laws has been made, and proposes certain new sections, amendments to make the laws conform to decisions of the Supreme Court, and the repeal of sections declared unconstitutional. A committee should be appointed to cooperate with other associations and with the state officials in making these laws more effective.

7. **Topographical Survey.**—As the State Geological Survey in cooperation with the U. S. Geological Survey has been engaged for 15 years in a topographic survey of Illinois, and as these surveys are of great value to the public in the development of plans for water supply, sewage disposal, land reclamation, flood control, railways, highways, etc., this work should be supported adequately by State and Federal appropriations to the end that the topographic mapping of the entire state may be completed as soon as possible.

8. **Instruction in Surveying.**—The Society expresses its approval of the establishment of a diploma department of Geodesy and Surveying at the University of Michigan.

The 37th annual meeting was held January 24-26 at the Orlando Hotel, Decatur, Ill.

January 24.—After the opening proceedings at 1:30 p. m., with the president, S. A. Greeley, in the chair, the meeting was turned over to the Surveying Section, with A. L. Webster, chairman, presiding. Papers were presented as follows: "Aerial Photography and Mapping," Ralph C. Diggins, Diggins Aviation Co., Chicago; "Analysis of Errors in Surveying," W. H. Rayner; "Instruction in Surveying at Purdue University," G. E. Lommel, Asst. Professor of Engineering; "Instruction in Surveying at the University of Michigan," T. J. Mitchell; "Licensing of Surveyors," W. D. Jones. President Greeley appointed committees as follows: Committee on nominations: G. C. Wiley, W. H. Collins, C. B. Burdick, W. A. Potter; Committee on resolutions; Robert I. Randolph, W. D. Jones.

The evening session was in charge of the Sewerage Section, H. E. Babbit, vice chairman, presiding. Papers were read as follows: "Sanitary Districts," Paul Hansen; "The Indianapolis Sanitary District," J. A. Craven, Indianapolis; "The Decatur Sanitary District," W. C. Field, Decatur; "Sanitary Districts in Illinois," H. H. Ferguson; "Storm Water Runoff in City Sewers," C. B. Burdick. The report of the committee on sewerage was read by Mr. Babbitt.

January 25.—The morning session was in charge of the Water Supply Committee, G. C. Habermeyer, chairman, presiding. Two papers were read: "The Decatur Dam," by J. A. Holmes, Decatur, and "The Miami River Flood Retention Dams," by A. L. Pauls, Decatur. The auditing committee (W. D. P. Warren and G. H. Reiter) reported the accuracy of the accounts. The meeting then adjourned for a motor trip to the new dam and to the pumping station of the Staley Co.

The afternoon session, in charge of the Roads and Pavements Section was presided over by C. C. Wiley, chairman. Papers were presented as follows: "Highway Research," W. K. Hatt, Purdue University; "Experimental Road Work of the U. S. Government," C. A. Hogentogler, highway engineer, U. S. Bureau of Public Roads; "Experimental Road Work in Illinois," C. F. Older, state highway engineer (read in the author's absence). After adjournment there was a visit to the works of the Mueller Mfg. Co., where supper was served. At the evening session, Prof. A. N. Talbot announced the award of prizes in the competition for papers: "Overflow Chambers in Intercepting Sewers," by W. T. McClenahan, and "Analysis of Errors in Chaining," W. H. Rayner. At the business session the committee on nominations presented two tickets, the ballot votes being as shown herewith: For president, R. I. Randolph (31),C. E. DeLeuw (10); for vice-president, H. E. Babbitt (21), A. L. Webster (20); for trustees, M. C. Taylor (25), W. D. Jones (21), H. L. Caldwell (20), G. F. Burch (14). For the next meeting both Peoria and Quincy gave invitations, but the decision was left to the Executive Board.

January 26.—At the morning session, G. E. Martin presiding, two papers were read: "Road Building Prospects in Illinois," Frank T. Sheets, state superintendent of highways; "Concrete Aggregate Resources of Illinois," H. F. Clemmer, engineer of tests, State Highway Division. There was also a discussion on the resurfacing of olr brick pavements. At the afternoon session, in charge of the Drainage Section and presided over by W. P. Bushnell, chairman, papers were read as follows: "Status of Drainage in Illinois," G. W. Pickels; "Legal Aspects of Drainage," F. B. Leonard, Jr., Champaign, Ill.; "The Illinois Waterway," M. W. Barnes, chief engineer, Division of Waterway (read in his absence by Mr. Cornish, assistant chief engineer). The annual

dinner was held at the hotel in the evening. The total registration during the meeting was 127, of whom 69 were members.

FINANCIAL STATEMENT: DECEMBER 31, 1921

Financial Statement: December 31, 1921

Bank balance, December 31, 1920		$ 452.09
Receipts, 1921		
Annual dues	$858.00	
Entrance fees	57.00	
Proceedings	2.60	
Advertisements	476.00	
Total for 1921		1393.60
Total receipts		1845.69

Expenditures

Printing and distributing "Proceedings"	$ 563.16
Printing and stationery	193.97
Bulletins	60.30
Stamps	54.73
Express and freight	13.15
Typewriting	30.55
Stenographer: 1921 Meeting, Chicago	90.00
Convention, miscellaneous expenses	9.00
Badges and buttons	31.50
Programs	60.00
Certificates of selection of officers	.55
Secretary	250.00
Subscription: Veterans, 108th Engineers	5.00
Subscription: National Drainage Congress	15.00
Prizes for papers	50.00
Executive committee; traveling expenses	67.62
Program committee, 1920, printing	95.11
Membership committee, 1920, printing	40.60
Committee on affiliation, 1920	13.91
Committee on cooperation	27.96
Local committee, 1921, posters	55.41
Miscellaneous	2.00
Total expenditures	$1729.52
Total receipts	1845.69

Bank balances, December 31, 1921		$ 116.17
Savings account (reserve)	$300	
Liberty bonds	$400	

REPORT OF THE SECRETARY

Several engineering societies with which we have exchanged "Proceedings" in the past have reduced their editions on account of the great cost of printing and have therefore reduced the number of their "Proceedings" furnished to this Society. It was impossible, therefore, to supply all members with all the exchanges, as had been done in former years. Notice of this change was sent to members with a request to indicate on a printed blank which exchanges they preferred (if any).

Comparatively few members asked for exchanges, and several wanted only those of two or three societies. This seems to indicate that members in general are not much interested in this part of the society's activities. Exchanges were arranged with the engineering societies of Iowa, Kansas, Michigan, Minnesota and Wisconsin. Our own "Proceedings" had to be kept within a small volume owing to high cost of printing and limited funds, several papers being omitted. But the papers printed were of high class and covered a wide field. Four bulletins were issued during the year.

The second competition of papers resulted in the receipt of six papers as below. The first two received prizes of $25 and are printed in the "Proceedings": "Overflow Chambers in Intercepting Sewers;" "Analysis of the Errors in Chaining;" "Organization of Drainage Districts;" Estimating the Time of Construction of Water Works Projects;" "Oxygen in Sewage Treatment;" "Resurfacing Old Pavements."'

A summary of the year's business is shown in the accompanying financial statement. The society, being an incorporated body the annual report of election of officers was filed with the County Recorder of Cook County, as required by law, the society being in that county.

E. E. R. TRATMAN, Secretary and Treasurer.

AMENDMENT TO THE CONSTITUTION: AFFLILIATION

During 1921 there was submitted by the special committee on affiliation a proposed amendment to the constitution to provide a course of action in the event of any proposition being made for the affiliation or amalgamation of the Illinois Society of Engineers with some other engineering society. This was sent out for ballot, but although a full vote was requested and stamped post cards were furnished, only 130 ballots were cast. The vote was decisively in favor of the adoption of the amendment, there being 115 votes "for" and only 15 "against." To the constitution as printed in the 1920 "Proceedings" there is now added the following clause:

"Article XIII: Whenever in the opinion of the Executive Board the objects and aims of the Society can be accomplished better and the Society can be of greater service to the engineering profession by becoming affiliated or amalgamated with another engineering society, or when a proposition for such affiliation or amalgamation shall be presented to the Executive Board signed by not less than twenty active members of the Society, then the Board shall print the reasons for and the details of the proposed plan and shall submit the same to the membership of the Society in the form of a letter ballot.

If the proposed plan of affiliation or amalgamation shall receive an affirmative vote of the majority of the active members of the Society then the Board, without further vote, shall enter into an agreement or contract in accordance with the plan submitted; provided, however, that any plan which may be rejected shall not be presented again before the next annual meeting.

The provision of Article XII on amendments to the constitution shall not apply to the proposition of affiliation or amalgamation."

ANALYSIS OF THE ERRORS IN CHAINING

BY W. H. RAYNER *(Prize Paper)*

The treatment of errors in precise surveying measurements such as those made in the U. S. Coast and Geodetic Survey, has been care-

ful and thorough. On the other hand, the treatment of errors in ordinary surveys has been crude and superficial. Indeed, all authors of text-books on surveying, with one or two exceptions, deal with the subject in a very superficial manner. This is perhaps, the natural consequence of surveying practice in this country where speed has been the first, and accuracy the second, consideration in most field work. In this paper an attempt is made to apply the theory of errors to the common process of measuring distances in ordinary surveying practice to the end that this important work may be done with greater satisfaction and intelligence than is now the case. For this purpose it will be desirable: 1, to state some of the principles of the theory of errors; 2, to discuss the nature of errors in chaining; and 3, to apply the theory by the use of an example.

Theory of Errors—Most of these definitions follow other writers except in the case of two terms, namely, "cumulates" and "remainders," which have been devised for this study. The accuracy of field measurements in surveying is affected by five factors: (a) cumulates, (b) constant errors, (c) remainders, (d) accidental errors, and (e) mistakes.

(a) Cumulates are differences from true values, which tend to affect the magnitude of observed quantities always in the same direction. The incorrect length of a tape, the effect of slope on taped distances, the incorrect value of the stadia constant (F)/(i), are examples of cumulates. The distinctive quality of this factor is that its effects can always be nearly eliminated by a computation; and a measurement which is affected by one or more cumulates is never completed until this correction has been made. They are most evident in taping.

(b) Constant errors are differences from true values which are always present and, like cumulates, affect the magnitude of observed quantities always in the same direction, but whose magnitudes are not easily calculated and, therefore, cannot be eliminated by computations. These, therefore, are a genuine source of error, and their effect is to be eliminated by systematic field methods. The adjustments of the surveying instruments are good examples of sources of constant errors. Thus, if the line of sight is not parallel to the axis of the bubble in the level, then we have a condition which always affects a reading on the level rod in the same way and the effect of which is eliminated by a systematic field method; that is, by keeping the lengths of backsights and foresights equal.

(c) Remainders. In the elimination of cumulates, two classes of small residual errors of unknown amount remain, some of which tend to affect the result always in the same direction and others are as likely to be positive as negative in their effect. The former class is called "remainders" and must be dealt with in a manner different from other kinds. The latter class affects the result ex-

actly as do accidental errors, and is, therefore, treated as such. An example of the first class, is the wrong length of tape. This source of error is treated, then, first as a cumulate, and the principal part of the error removed by a computation. There remains, however, a small residual error of unknown amount; and while this error is of unknown sign, plus or minus, yet the distinctive fact about it is, that it will always, for a given tape, have the same sign and will tend to affect the measured length always in the same direction. The resulting error is, therefore, called a remainder.

(d) Accidental errors are differences from true values which remain after cumulates and constant errors have been eliminated. Since these are permanent and inherent in all measurements, they are of great importance and have been the subject of much investigation and mathematical treatment, under such titles as Theory of Observations, Methods of Least Squares, Adjustment of Observations, etc. These errors are subject to three important laws, namely: 1, large errors do not occur, or when they do occur the observation is rejected; 2, small errors are more frequent than large ones; 3, errors of the same magnitude and of opposite sign are equally numerous; that is, an accidental error is as likely to be positive as it is to be negative.

(e) Mistakes are differences from true values which arise from carelessness. They are detected only by checking the observations and therefore no measurement is completed until it has been checked, by a different method if possible. It need not be added that mistakes have no part in a discussion of the theory of errors.

Formulas.—From the theory of the propagation of errors if we, Let $X = A_1 + A_2 + A_3 + ---- A_n$ where A_1, A_2, etc., are independently served quantities; and let e_1, e_2, e_3, $----$ e_n represent the error in A_1, A_2, A_3, $----$ A_n; also let e_x represent the error in X. Then,

$$e_x = \sqrt{e_1^2 + e_2^2 + e_3^2 + ---- e_n^2} \quad \ldots\ldots\ldots \quad (1)$$

If $x = A_1\ A_2$ (product), then

$$e_x = \sqrt{A_2^2\ e_1^2 + A_1^2\ e_2^2} \quad \ldots\ldots\ldots\ldots\ldots \quad (2)$$

NATURE OF ERRORS IN CHAINING

Sources.—The principal sources of error in taping are well known, and may be designated as follows:

(a) Incorrect length of tape, E_l
(b) Slope of the ground or grade, E_g
(c) Inaccurate alinement, E_o
(d) Marking tape lengths, E_m
(e) Changes in temperature, E_t
(f) Variations in pull, E_p
(g) Sag in tape, E_s
(h) Effect of wind, E_w

Magnitude of Cumulates.—The value of the cumulates to be applied to surveying measurements may be easily determined for known conditions, as for example the wrong length of tape, the effect of temperature, slope, etc. All text-books give these values and they need not be given here.

Remaining Errors.—After the correction for cumulates have been made, there remains one or more of the three classes of errors, namely, remainders, constant errors, and accidental errors. For example, since true horizontal distances only are desired in taping, it will be necessary on sloping ground to remove the cumulate from the measured length. And in accurate measurement this will be true in case the tape is ''stretched level'' as well as when it is stretched on the ground; for in either case there will be a deviation, however small, from the truly horizontal position. After this cumulate has been removed, there will remain small accidental errors E_g, whose amount will depend on the accuracy of the determination of the cumulate. A similar analysis of the various sources of error reveals the fact that wherever there is a cumulative, there is also either a remainder or an accidental error.

Analysis Before Field Work.—It should be stated again that this analysis is based on the assumption that the effect of all cumulates is removed by the proper computations, and applies, therefore, only to the remainders and accidental errors.

Two types of analysis may be made by the surveyor, the first to be made before, and the second after the field work has been completed. The purpose of the first is to determine what methods and instruments shall be used in the field; the purpose of the second is to determine what degree of precision in the field work has been attained. A list of the steps to be taken in the first case is given below:

1. Decide on the degree of accuracy desired, expressed as the ratio of the allowable error to the total distance; as one part in a thousand or one part in five thousand.

2. Calculate the total probable error in feet. The allowable error assumed in step (1) comprises all the sources of error in chaining and we must now seek some means of assurance that this allowable error shall not be exceeded. The probable error expresses the idea that the odds are even, one to one, that the error contained in a given result, will not exceed the value of the probable error. Now if we reduce the size of the probable error to one-half the allowable error (assumed in step 1) then the odds become 8 to 1 approximately that the error contained in the result will not exceed the allowable error. These odds (8 to1) are usually considered adequate and now the actual probable error in feet can be calculated, by taking one-half the assumed allowable error in step (1).

3. Make a table of the sources of error and analyze each as to the class or classes of error to which it belongs.

4. Estimate the value of, and record value for each item under (3). The surveyor now uses his knowledge of the relative importance of the various sources of error and assigns their values.

5. Calculate the total effect of the remainders, E_r (by formula 1).

6. Calculate the total effect of the accidental errors, E_a (by formula 1).

7. Calculate the total probable error, E_1 (by formula 1).

8. If this value E_1 is too large or too small, readjust the values under (4) accordingly.

9. Determine the field methods necessary to yield results consistent with the assumptions under (4). From a knowledge of the magnitudes of errors due to various field conditions, the surveyor prepares a list of specifications which will be adequate to secure the results assumed in step (4).

APPLICATION OF THE THEORY

Example.—Let it be supposed that it is desired to measure a line with an allowable error of one part in 5000 parts, and that the line is approximately one mile long. The analysis would proceed as follows:

1. The allowable error is 1/5000 or 1.0 ft.
2. The probable error is 1.0/2=0.5 ft.

3 and 4.

Sources	Cumulates	Remainders Ft. per 100 ft.	Accidental Errors Ft. per 100 ft.
Length of Tape	√	±.003	
Temperature	√	±.004	
Pull			±.003
Grade	√		±.02
Alinement	√		±.005
Marking			±.03
Sag	√		±.02
Wind	√		Neglect

5. $E_r = \pm\sqrt{(.003^2 + .004^2)\ 52^2} = \pm.25$ ft.

6. $E_d = \pm\sqrt{52\ (.003^2+.02^2+.005^2+ .03^2+.02^2)}=\pm.29$ ft.

7. $E_1 + \sqrt{.25^2+.29^2}=\pm.38$ ft.

8. Revise E_t to $\pm.008$ and then $E_1=\pm.51$ ft.

9. The errors listed under Remainders, are maximum errors; those under Accidental Errors are average errors. It is known that the maximum error in a series of observations will be at least double the average error and hence in writing the specifications which apply to the accidental errors it will be proper to use field

conditions, which yield errors approximately double the size listed for the accidental errors. By the use of a knowledge of the magnitude of errors in field work the following specifications may now be written:

(a) The length of the tape must be known within ±.003 ft.
(b) The average temperature of the tape must be determined correctly with in ±7° F.
(c) The pull on the tape must not vary from the standard by more than 5 lbs. when supported, nor by more than 3 lbs. when unsupported.
(d) The slope must be estimated within ±3 per cent.
(e) Alinement must be estimated correctly within 1.4 ft.
(f) The pins must be set within ±.06 ft. of their true position.
(g) Wind may be neglected.

Analysis After Field Work.—It is clear that the analysis given above can easily be applied to completed field work, to compute the probable error. This is especially desirable in the case of traverses which do not close and therefore afford no check on the measured distances.

CONCLUSIONS

The foregoing analysis, it is believed, warrants the following conclusions:

1. That what are usually considered errors in taping are not errors at all, but cumulates to be removed from the measured length by computations.

2. That except for the incorrect length of tape and the effect of temperature, all sources of error in taping (after the cumulates have been applied) are compensative in nature. Hence we may expect errors in tape measurements which are treated by this method to vary as the square root of the number of tape lengths, rather than directly with the distance as is ordinarily assumed.

3. That the method indicated here provides a treatment for the combined effect of all sources of error in chaining which should enable the surveyor (a) to plan his work more intelligently, and (b) to determine within narrow limits the degree of accuracy, under given field conditions, which he has obtained by his field measurements.

OVERFLOW CHAMBERS FOR INTERCEPTING SEWERS

BY W. T. McCLENAHAN *(Prize Paper)*

Overflow chambers are generally designed to abstract a portion of the combined sewage from existing sewers for conveyance by an intercepting sewer and treatment or discharge elsewhere. Sewage in excess of this predetermined amount is usually allowed to overflow through the old sewer outlets, according to the theory that the

sewage so diluted with rain water will create no nuisance. The fixing of this amount that is to be intercepted is a very important matter. Decisions to be wise must be based on a careful study of all the prevailing sanitary conditions, both present and prospective, together with an analysis of the cost of all the improvements affected and of the aesthetics and other related matters. Hasty decisions or careless studies may lead to costly mistakes.

As a general rule, the amount to be intercepted is expressed in terms of the dry weather flow. Common practice is to intercept from 3 to 6 or even 8 times that flow, depending on conditions, and there is no reason why even greater ratios than these may not be used in special cases. After fixing the ratio, the next step is to establish the approximate location, size and grade of the new sewer. These features depend, of course, on the nature of the ground, the location and elevation of existing structures, especially sewers, and the requirements of the treatment plant. They also depend on the type and design of the intercepting chambers. Final grades must be made to accommodate these structures, also, and the selection of the type of intercepting chamber may be determined by the requirements of head available.

To be really effective in taking off the exact amount of sewage which it has been determined to abstract from each and every old sewer, the intercepting chambers must be made to fit each particular case. Many kinds of intercepting chambers and regulating devices have been devised and used, but this discussion will be limited to two types believed to be best suited for inserting in existing sewers, namely, the leaping weir and the overflow weir.

The Leaping Weir.—It is intended here to consider only the simplest form of the leaping weir; namely, a slot cut in the invert of the sewer from which a portion of the flow is to be taken. The size and shape of this opening concerns us most, but the installation itself will also be considered. As a general rule, the slot must be set in the peripheral surface of the old sewer, with both upstream and downstream lips in the same grade plane. However, instances do occur in old sewers where the downstream lips can be set below the upstream grade plane. This occurs where the chamber is built at or near a drop manhole. For reasons made apparent later, it is desirable to keep the lips in the same grade plane. The sewer is assumed to be circular, but the designer ought to have little trouble in applying the principles here outlined to other shapes of sewers and to the special case where the downstream lip is depressed below the upstream lips.

The following solution, although based on inexact assumptions, is believed to be reasonably accurate and satisfactory. With any kind of intercepting device, some adjustment of the edges or control is desirable, for too many assumptions must be made to be too confident of the setting of the device, and, besides, the conditions in the

old sewers change from year to year, so that a new setting may become imperative later on.

Consider a sewer whose diameter is D where just the quantity of water is flowing which it is desired to intercept. The depth of flow at the center is d and the average velocity over the whole flow section is V. Although the assumption is inexact (due to retardation by friction of the water along the sides of the sewer), let us for simplicity suppose that all drops of water travel at the same velocity. Then (Fig. 1) each drop of water, as it leaves the upper edge of

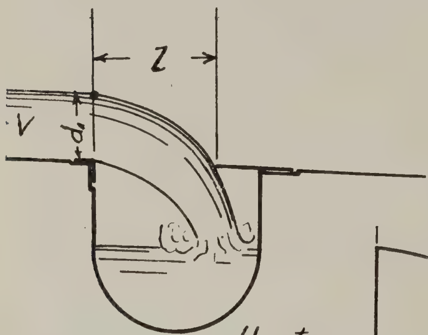


FIG. 1

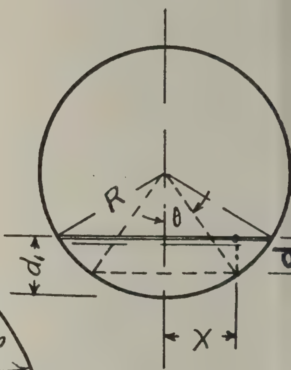


FIG 2

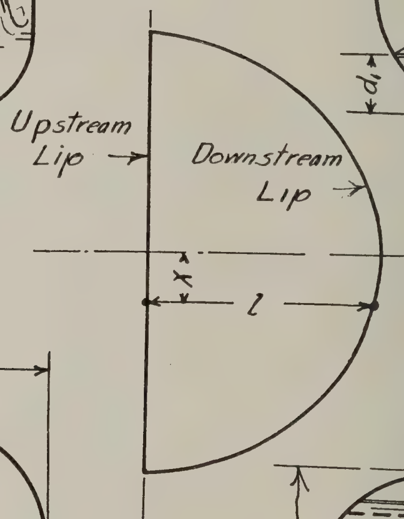


FIG. 3

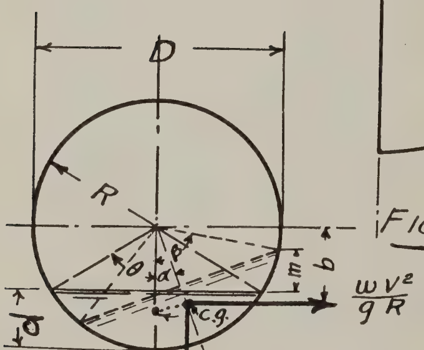


Fig. 4

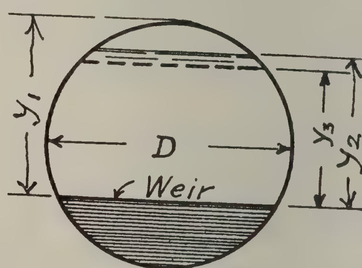


FIG 5

the slot, has two velocities, an initial velocity parallel to the grade plane, and a velocity imparted by the acceleration of gravity; therefore, drops along a line in the surface of the flow parallel to the upper edge of the slot as they fall and more forward from the upper lip describes a parabolic surface curved downward. The problem is to find the line where this parabolic surface cuts the inside surface of the sewer.

The horizontal distance traveled by any drop is expressed by the equation

$$l = V\,T \quad - - - - \quad (1)$$

T is the time during which the velocity, V, acts, and l is the distance travelled. For drops in the top surface, the equation expresses the distance travelled from the upstream to the downstream edge of the weir and so determines the shape of the weir. Neglecting the effect of the sewer grade, we have from the law of falling bodies,—

$$t = \sqrt{\frac{2\,d}{g}} \qquad (2)$$

where d is the vertical distance through which the drop falls.

$$\text{Therefore} \quad l = V\sqrt{\frac{2\,d}{g}} \qquad (3)$$

At the center of the section d = d, at any other point (see Fig. 2);

$$d = d_1 - R \text{ Vers } \underline{\theta} \qquad (4)$$

Where $\underline{\theta}$ is the angle whose sine is $\frac{X}{R}$ and X is the distance that the drop is travelling from the center of the section. Inserting this value for d in equation (3) above, we find that,—

$$l = V \; \frac{2(d_1 - R \text{ Vers } \underline{\theta}}{g} \qquad (5)$$

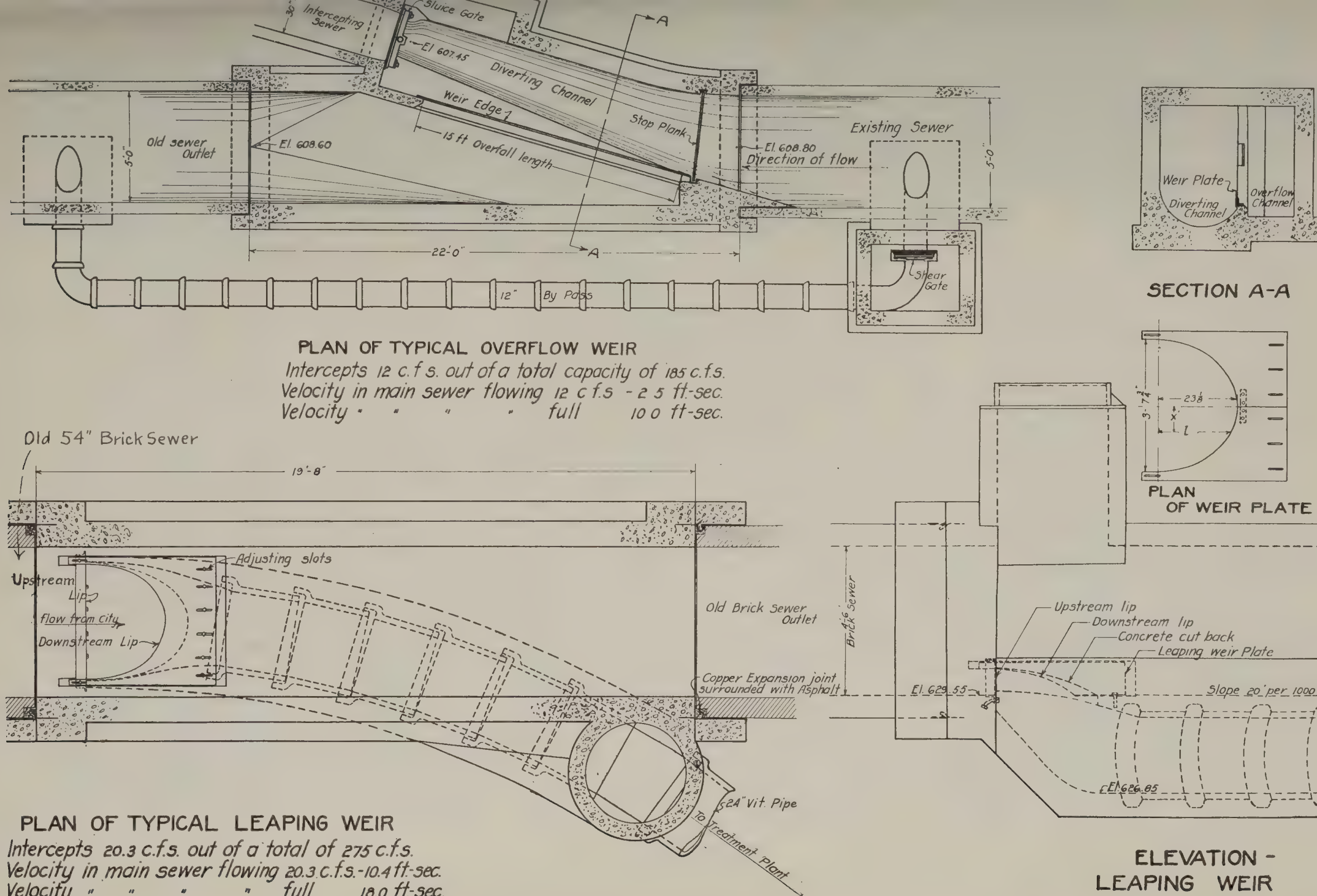
$$\text{Also,} \quad X = R \text{ Sine } \underline{\theta} \qquad (6)$$

The last two equations give the coördinate of projection on the horizontal plane of any point in the downstream lip with reference to the upstream lip, and the center of the sewer.

If the slot is to be made from a flat piece of steel cut to shape and then bent to the radius of the sewer, it is necessary to change the expression for X to one for the arc distance X^1. This expression is,—

$$X^1 = \frac{\Pi}{180} \; R \; \underline{\theta} \qquad (7)$$

In this expression, X^1 is the distance to be measured on the flat sheet from the axis of the opening. (See Fig. 3.) The l distances remain the same as before.


Sluice Gate
Intercepting Sewer
30"
El 607.45
Diverting Channel
Weir Edge
Stop Plank
15 ft Overfall length
Old sewer Outlet
El. 608.60
5'-0"
Existing Sewer
El. 608.80
Direction of flow
22'-0"
A
12" By Pass
Shear Gate
PLAN OF TYPICAL OVERFLOW WEIR
Intercepts 12 c.f.s. out of a total capacity of 185 c.f.s.
Velocity in main sewer flowing 12 c.f.s - 2.5 ft-sec.
Velocity " " " full 10.0 ft-sec.
Weir Plate
Diverting Channel
Overflow Channel
SECTION A-A
3'-7¼"
2⅜
x
l
PLAN OF WEIR PLATE
Old 54" Brick Sewer
19'-8"
Adjusting slots
Upstream Lip
flow from city
Downstream Lip
Old Brick Sewer Outlet
Copper Expansion joint surrounded with Asphalt
24" Vit. Pipe
To Treatment Plant
4'-6" Brick Sewer
Upstream lip
Downstream lip
Concrete cut back
Leaping weir Plate
El. 629.55
Slope 20' per 1000'
El. 626.85
PLAN OF TYPICAL LEAPING WEIR
Intercepts 20.3 c.f.s. out of a total of 275 c.f.s.
Velocity in main sewer flowing 20.3 c.f.s.-10.4 ft-sec.
Velocity " " " full 18.0 ft-sec.
ELEVATION - LEAPING WEIR

In Fig. 6 is shown an intercepting chamber designed along the lines here given. It is to be noted that the receiving box beneath the slot is smoothly shaped and that the intercepting sewer is brought out on a curve so as to cause little disturbance below which might interfere with the proper functioning of the weir. It is also to be noted that the intercepting sewer must come from beneath the old sewer, so that the chamber requires considerable loss of head.

Another point to be noted is that where flows occur in the old sewer in excess of the amount to be intercepted, the velocity in the main sewer being greater, a lesser amount of sewage will be caught by the interceptor. If the downstream lip be dropped, the effect of this change of velocity in the main sewer becomes more apparent, so that at certain flows the sewage stream may jump clear over the slot. For this reason slot lips in the same grade plane are generally to be preferred.

The Overflow Weir.—Mr. W. C. Parmley, in a paper in *Tran. Am. Soc. C. E.*, Vol. 55, p 341, (quoted by Metcalf and Eddy in "American Sewage Practice," Vol. 1, p. 607) takes up the design of an overflow weir of the free-fall type. Mr. Parmley does not, however, go into all details, nor does he apply the equations to a submerged weir, which is the kind of weir generally met with in old sewers. We will, therefore, discuss several features of the overflow weir not covered by Mr. Parmley in his paper.

(1) *Centrifugal Action and Weir Heights.*—When the velocity of the water in the main sewer is high and an attempt is made to bend the course into the interceptor by means of a weir or dam, the flow section has a tendency to rotate in the channel, with the result that the water is piled up against the weir. The surface of the water probably takes something of a parabolic shabe, but for our purposes let us assume that it remains a plane surface, tipped up by the tangential forces.

In Fig. 4 let

d = depth of flow
v = average velocity in flow section
w = weight of water in unit length
g = gravity
R = radius curvature of channel

To find:—

M = the distance the outpoint of the flow section raises above the level position.

The section is acted upon by three forces:—

(1) A vertical force due to gravity $\frac{w}{g}$

(2) A tangential force which, by mechanics, we find is equal to $\left(\frac{w}{g}\right)\frac{V^2}{R}$

(3) Supporting force contributed by the shell of the sewer.

The last force is always the resultant of the other two and does not interest us here.

Rotation equilibrium will be established when

$$\frac{w}{g} \times a = \frac{w}{g}\,\frac{V^2}{R} \times b \qquad (8)$$

Where a and b are the moment arms of the two forces applied as if at the center of gravity of the section,

$$\text{Then,}\quad a = \frac{V^2 b}{R} \qquad (9)$$

and,

$$b = \frac{X_o\, R}{\sqrt{V^4 + R^2}} \qquad (10)$$

(X_o is the distance from the center of sewer to the center of gravity.)

The angle through which the section rotates is found from the equation,—

$$\operatorname{Cos}\alpha = \frac{R}{\sqrt{V^4 + R^2}} \qquad (11)$$

Half the arc of wetter perimeter is $\underline{\theta}$ which is expressed by

$$\operatorname{Cos}\frac{\theta}{\quad} = \frac{R-d}{R} \qquad (12)$$

$$\text{Then Angle}\quad \beta = \alpha + \underline{\theta} \qquad (13)$$

$$\text{And}\quad M = R - d - R\cos\beta \qquad (14)$$

With very low velocities the effect of the tangential forces is less apparent, but for high velocities and an abrupt change of direction, the effect may be such as to render all other computations of little value. It should be noted that at the beginning the velocity along the weir is that of the old sewer, while at the end of the weir it is that of the intercepting sewer, so that the water raises a different amount at the two ends.

(2) *Effect of Changing Velocity on Weir Length.*—Mr. Parmley gives the length of the weir as

$$L = V\,t$$

The velocity at the beginning and end of overflow is not the same,

as pointed out in the paragraph above. The change in velocity is probably not according to a straight line equation, but for practical purposes the average velocity between the two ends may be taken for V and used in the equation.

(3) *The Finding of W.*—It is a pity that Mr. Parmley's equation for the time of discharge has never been integrated, inasmuch as the approximate formula introduces some troubles. For instance, what is the proper method of arriving at the width, W? It is apparent that when a sewer is flowing full a straight change in the depth of flow over the weir affects the rate of discharge much more than it affects the actual discharge as represented by a small area at the top, whereas, for a sewer flowing half-full a slight change in the depth of flow affects the actual amount of discharge much more than it affects the rate. A little thought will show that an average W arrived at by dividing the area of discharge by the depth gives a constant discharge for each unit of depth, and that the time for lowering the water surface a given amount when so computed will be less than it would be if determined by an accurate equation. However, no better short method for solving this problem has been found, and, so, since the accuracy of some of the assumptions may be somewhat in error anyway, the approximate solution is generally used by us. Nevertheless, the limitations of the formula should be kept clearly in mind.

(4) *The Submerged Weir.*—Most overflow weirs inserted in old sewers are submerged when the sewer is flowing full. The formula for time for overflow as written by Mr. Parmley will not then apply. It is possible, however, by use of Herschel's coefficient for submerged weirs to so modify the expression for time that it will apply. So written, the expression becomes,—

$$T = \frac{w}{1.67} \quad \frac{1}{\sqrt{N_2\ Y_2}} - \frac{1}{\sqrt{N_1\ Y_1}} \qquad (15)$$

Let us assume a sewer of diameter D to be flowing with a head y_1 on the weir at the beginning and y_2 at the end of the overflow. Assume, also, that the overflow sewer, after having had a portion of the flow removed through the interceptor, backs the water up over the weir to a depth of y_3. Then the expressions

$\frac{Y^1}{Y_3}$ and $\frac{Y^2}{y_3}$ will correspond to $\frac{h^1}{h}$ in Herschel's tables.

From these expressions, values for n, and n_2 can be read from the tables and substituted in formula (15). Otherwise, the computation for the length of weir is the same as for a weir with a free fall. The accompanying table of Herschel's coefficients is taken from

Hughes & Safford's book on "Hydraulics." From the above discussion of the overflow weir, it is apparent that a good many factors enter into the computations for length. It is also apparent that it is desirable to make the weir adjustable for height. Fig. 6 shows an overflow chamber which is being built according to the ideas here put forward.

COEFFICIENT n, HERSCHEL'S SUBMERGED WEIR FORMULA

$\frac{H_1}{h}$	1	2	3	4	5	6	7	8	8	9
v.0	1.000	1.004	1.006	1.006	1.007	1.007	1.007	1.006	1.006	1.005
0.1	1.005	1.003	1.002	1.000	0.998	0.996	0.994	0.992	0.989	0.987
0.2	0.985	0.982	0.980	0.977	0.975	0.972	0.970	0.967	0.964	0.961
0.3	0.959	0.956	0.953	0.950	0.947	0.944	0.941	0.938	0.935	0.932
0.4	0.929	0.926	0.922	0.919	0.915	0.912	0.908	0.904	0.900	0.986
0.5	0.892	0.888	0.884	0.880	0.875	0.871	0.866	0.861	0.856	0.851
0.6	0.846	0.841	0.836	0.830	0.824	0.818	0.813	0.806	0.800	0.794
0.7	0.787	0.780	0.773	0.766	0.758	0.750	0.742	0.732	0.723	0.714
0.8	0.703	0.692	0.681	0.669	0.656	0.644	0.631	0.618	0.604	0.590
0.9	0.574	0.557	0.539	0.520	0.498	0.471	0.441	0.402	0.352	0.275

Conclusion.—In conclusion, it may be said that where the sewer grades are light, with consequent low velocities, where the quantity taken off by the interceptor is quite large and where the head sacrificed in the interceptor must be kept at a minimum, the overflow weir will be found most suitable. On the other hand, where the old sewer is on a steep grade with consequent high velocities, where the requirements of head lost are not important, and where the new sewer is small, the leaping weir is often best suited. Both types are good and have their places for best service and it is the duty of the engineer to select the best weir for each and every case.

SANITARY DISTRICTS

BY PAUL HANSEN

This symposium is in the nature of an experience meeting on organizing, financing, installing and operating sewage disposal projects with special reference to the device originated in Illinois and known as the sanitary district. There are a number of well known difficulties in the way of the successful inception and maintenance of sewage disposal undertakings. The first and fundamental difficulty in the majority of cases is the lack of interest on the part of the public producing the sewage.

As ordinarily built, sewerage systems carry the sewage beyond the immediate confines of the community and discharge it into the most available water-course. Sometimes these water-courses

are so small that a serious nuisance is created, but the sufferers from such a nuisance are usually outside the town and comprise farmers whose land borders or lies across the stream. Occasionally, however, another community or an industry is the sufferer and quite frequently there is complaint among amateur fishermen on account of the destruction of fish life.

Unless these various injured parties can prove in court that they suffer damages somewhere near as great as the cost of sewage treatment works, it is not probable that anything will be done in the matter, even when the offending municipality recognizes its moral obligation to cease dumping filth onto others. In some instances the polluted portion of the stream receiving sewage may pass through the city itself, in which case the public is more friendly to improved sewage disposal. But even this is more apt to lead to prolongation of the outfall sewer, which merely transfers the nuisance from under their own noses to a position more directly under the noses of their neighbors.

Some states have effective laws giving state departments of health, or other bodies, power to enforce the installation of sewage treatment works. That in Pennsylvania gives the State Commissioner of Health, power to prevent any extension of a sewerage system until treatment works are built. That in Ohio impowers the State Department of Health to order the installation of treatment works and without submitting the matter to the vote of the people. But even these rather drastic laws have their limitations, because after the works are built there may be no funds available for proper operation, or the city may not make suitable provision. In other words, there is lacking some agency with taxing power and executive and administrative functions to build, extend, operate and maintain works for the collection and final disposal of sewage.

In Illinois, present laws do not provide adequate means for compelling municipalities to install sewage treatment works. About the only way of enforcing present laws, giving state agencies authority over sewage disposal, is by securing court decision enjoining the use of sewers until treatment works are installed. This method is so drastic that its application would defeat the objects of sanitation, which the law is supposed to encourage. This throws the whole matter back upon regulation through private damage suits, through which injured parties may seek to recover damages or have the nuisance abated. The attitude of state bodies may, however, have an important influence on the outcome of these damage suits.

Once an Illinois community is committed to the policy of installing sewage treatment works as a result of real or threatened damage suits, or through more altruistic motives, the so-called sanitary district laws afford a very good means for financing, construc-

tion and taking care of maintenance and operation. The first of these laws, that for the Chicago Sanitary District, was a piece of spceial legislation enacted in 1889 to enable the city of Chicago and neighboring towns to divert sewage from Lake Michigan, where it was polluting public water supplies and causing thousands of deaths and tens of thousands of cases of sickness annually.

The District built a drainage canal from Lake Michigan to the Illinois River valley and arranged for the diversion of lake water in amounts that it was believed would dilute the sewage from the District. Unfortunately the polluting power of industrial sewage was not fully reckoned with and the Federal Government refused to permit the diversion of sufficient quantities of diluting water from Lake Michigan. Until recently the Chicago Sanitary District was not disposed to make up for the deficiency of diluting water by installing treatment plants, but now a program is being worked out for the successive installation of such works, that within a reasonable time should relieve objectionable pollution in the Desplaines and Illinois rivers.

The maintenance problems of the District have always been well taken care of both financially and with reference to operation, barring minor mismanagement through politics from time to time.

After the Chicago Sanitary District law, including various amendments and extensions, had demonstrated its practicability and had been pretty thoroughly tested out legally, the North Shore communities recognized the advantages of a similar law for handling their sewage disposal problems jointly. As a result, a second sanitary district law was passed in 1911, having special reference to the problem of this group of communities.

In 1914 the city of Decatur was confronted with the necessity of treating its sewage and raising funds for the purpose. The problem of taking in other communities or surrounding territory was not particularly pertinent, but the device of a sanitary district did have considerable merit in the matter of raising funds beyond the limits prescribed by state law for municipalities. Accordingly, at the instance of Decatur, and largely through the individual efforts of Judge James S. Baldwin, a third sanitary district law was passed by the legislature, modeled closely on the two previous laws, but made applicable to all incorporated places in the state. Decatur took advantage of the new law passed in 1917; since then, Bloomington, Champaign, Urbana, El Paso and Downers Grove have taken advantage of it and other cities are contemplating its use.

Though perhaps not ideal in conception and operation, the sanitary districts, as developed in Illinois, seem to constitute the most generally applicable and workable legal arrangements thus far devised for governing, financing, construction and maintaining works for the collection and final disposal of municipal sewage.

There seem to be no good reasons why the functions of sanitary districts might not be extended to cover water supply and even parkways, as in the case of the newly organized Metropolitan District Commission of Boston and vicinity. There are, of course, other districts throughout the country more or less successfully organized to carry out and maintain water supply and sewage disposal projects, but these are nearly all special in nature and not susceptible to such wide applicability, as is the latest of sanitary district laws in Illinois. Among others besides the Metropolitan Commission are:-

The New Orleans Water and Sewerage Board, a purely local organization, designed to give continuity and efficiency to water and sewerage undertakings which in the case of this city are unusually important and difficult undertakings. The Syracuse intercepting board, also purely local. The Fitchburg sewage disposal commission. The Washington suburban district of Maryland. The Indianapolis sewerage district. Sanitary districts in Indiana, somewhat similar in organization and power to the Illinois sanitary districts, but with authority extended to cover the collection and disposal of garbage. The Joint Meeting of the inhabitants of the city of Plainfield, the borough of North Plainfield and the borough of Dunellen. The Passaic Valley sewerage district. The Miami conservancy district for flood prevention. The Milwaukee sewerage commission. The Board of Water Supply of New York City.

SANITARY DISTRICTS IN ILLINOIS

BY HARRY F. FERGUSON

There are three laws now in force in Illinois regulating the formation and operation of sanitary districts, primarily for the disposal of sewage and drainage from built-up areas. Two of these laws are for special sanitary districts; one controls the Sanitary District of Chicago and the other the North Shore Sanitary District, which district takes in an area from the northern boundary of the Sanitary District of Chicago to the Wisconsin line. The third law, passed in 1917, has general application within the State. The essential features of the sanitary district law of 1917 are as follows:

(1) Contiguous territory containing one or more cities, villages, or towns, or part of one or more cities, villages, or towns so situated that a common outlet sewer and treatment plan will conduce to the preservation of public health may be incorporated as a sanitary district. No territory which is located more than three miles from a city, town, or village can be included in a district.

(2) One hundred voters resident in a proposed district may petition the county judge of the county in which the major portion of the proposed district is located to submit the question of formation of a district to the voters. The petition must describe definitely the boundaries of the proposed district.

(3) Upon receiving petition the county judge shall select two circuit judges of the circuit court embracing the proposed district or major part thereof, and the three judges form a board to consider the boundaries.

(4) The county judge shall give due public notice of a proposed meeting of the board of three judges to consider the boundaries of the proposed district, at which meeting any person resident in the proposed district can be heard relative to boundaries (but not relative to the general advisability of such a district).

(5) Decision of two of the three judges relative to the boundaries is conclusive and not subject to review.

(6) After fixing the boundaries the county judge shall submit the question of the formation of a district at an election to be held within 60 days of the order of the board of three judges fixing the boundaries Public notice and description must be given.

(7) If majority vote favors district then district shall be deemed organized.

(8) Within 20 days of election, approving formation of district, the county judge shall appoint three trustees to serve one, two, and three years respectively. Each year the county judge shall appoint one trustee to fill the vacancy of the retiring trustee, and the county judge shall make appointments at any time to fill vacancies caused by death or otherwise.

(9) Not more than two trustees may be resident of any one city, village or town if more than one city, village, or town or parts thereof are included in the district.

(10) The trustees shall elect one member as president and one member as clerk, and have right to select treasurer, engineer and attorney and fix salary of all employees of the district. The trustees shall not receive more than $100 per year.

(11) Ordinances imposing penalty or making appropriation must be published.

(12) Trustees have power to provide for disposal of sewage and drainage including treatment of sewage from area within district, and to preserve water supplies used by inhabitants of the district, but do not have power to operate waterworks.

(13) A sanitary district can acquire land, personal property, and right-of-way for sewer outlets and shall have right to condemn and acquire property for just compensation.

(14) A district can borrow money and issue bonds up to 5% of value of taxable property as determined at the last assessment for State and county taxes.

(15) Bond issues must be approved at a general election and the trustees shall appoint judges and clerks of such election.

(16) An annual tax shall be provided to pay off any bonds in annual installments of not more than 20 years, and the interest on such bonds. Other taxes can be levied by the trustees for corporate purposes up to half of one per cent of the value of taxable property. A like sum in addition can be raised by tax levy if approved by majority vote at an election.

(17) Work exceeding $500 shall be let by contract to lowest bidder.

(18) A sanitary district may permit, upon suitable terms, territory outside of district to drain into district channels or drains, and may contract for use of ditch or channel of any other sanitary district.

(19) A sanitary district can exercise sanitary control of public water supplies in the district and over territory included within a radius of fifteen miles from the intake of any such water supply.

Advantages and Disadvantages of Sanitary Districts.—There are many advantages to be gained at many places by the creation of

sanitary districts in accordance with the 1917 law, and sanitary districts already formed have made possible big improvements in the opportunities for properly handling certain sewerage projects. There are some disadvantages, but whenever a sanitary district seems at all advisable the disadvantages are generally of a minor character and more than offset by the advantages to be gained. The advantages of the sanitary district law may be enumerated as follows:

(1) Permits the establishment of new or improved sewer outlets and treatment plants to serve area in a natural drainage district regardless of artificial corporate boundaries of cities, villages, or towns. This important advantage will probably be appreciated more by engineers than by any other group of men, as it conforms to good engineering, but good engineering is good business and economy, and it should be appreciated by all citizens.

(2) Permits construction of intercepting sewers and treatment plants to serve system or systems of sewers already installed, but in need of improvement. This advantage is somewhat similar to the one given above, but relates especially to those cities that have installed systems piecemeal, and are confronted with the necessity of better sewerage facilities and sewage disposal.

(3) Provides means for financing needed intercepting and main sewers and treatment plants regardless of bonded indebtedness of any city, village, or town in the district. This is an important advantage for the public desire for more adequate sewerage facilities and cleaner streams often could not be carried out heretofore because of lack of lawful means of financing such improvements.

(4) Provides means of financing operation of treatment plants and main sewers and, therefore, should insure better operation. Many sewage-treatment plants have been installed which have never been properly operated to give the purification of which they were capable because of lack of maintenance funds.

(5) Provides reasonably fair distribution of cost of such improvements.

(6) Increases likelihood of competent persons being in administrative charge of such work and lessens likelihood of change in personnel responsible for disposal of sewage and maintenance of treatments plants, thus conforming to good engineering and good business and involving less politics of objectionable and costly character.

(7) Provides effective means for sanitary control of public water supplies obtained from surface courses in districts. This power might better be invested in the municipalities owning or using the supplies, but in the absence of such effective power by municipalities, it is beneficial to have some interested organization have such power.

Disadvantages of a sanitary district are as follows:

(1) A sanitary district is not entirely suitable for a complete sewerage project, including lateral sewers, especially where costly outlet sewer and treatment plans are required, because a bond issue of five per cent of the assessed valuation is not adequate. It is not advisable to attempt to install a complete sewer system, including laterals, under the sanitary district law for this financial reason. There is also some question whether or not the law authorizes the installation of lateral sewers in this manner.

(2) The creation of a sanitary district to handle only outlet sewers and treatment plant results in two or more separate corporate bodies, having certain (though not overlapping) jurisdiction over parts of sewerage installations and may increase slightly the overhead cost of total sewerage work because of a division of the work between two separate administrative bodies and two engineers. This disadvantage is negligible compared to the advantages of having a sanitary district if two or more cities, villages, or towns, or a single city, village, or town and adjoining territory are involved, and a common sewer outlet and treatment plans are possible. If only a single city, village, or town and little or no outlying territory will comprise a proposed district, this disadvantage will be important or non-important, dependent upon the size and population of the district and magnitude of the proposed installation and whether or not the municipality can otherwise finance the construction and satisfactory maintenance of the necessary outlet sewer and treatment plant.

(3) The control of property connections to sewers will not generally come under the district trustees, who are responsible for the operation of the treatment plant and size of outlet sewers. This condition would be a disadvantage only if municipal officials did not properly regulate the use of sewers, installed for sanitary drainage only, so as to prevent excess flow to the treatment plant and possibly objectionable industrial wastes to enter the collecting system.

Since the passage of the law in 1917, there have been five sanitary districts formed under that law. Four of these districts were formed to provide intercepting and main outlet sewers and treatment plants, and one for a complete sanitary sewer system. Information relative to these districts is given herewith:

Bloomington: Intercepting sewers; overflows for storm water; treatment plant. Trustees: J. W. Harper, prest.; F. D. Barber, v.-pres.; J. J. Condon, clerk. Engineers, Taylor & Woltman. Consulting engineer, Chas. Brossman. Attorney, R. F. Dunn.

Decatur: Intercepting sewers and treatment plants. Trustees: W. C. Field, pres.; W. M. Wood, v.-pres.; P. J. Millikin, clerk. Engineers, P. T. Hicks, P. T. Oetzel. Consulting engineers, Pearse, Greeley & Hansen. Attorneys, McMillan & McMillan.

Downers Grove: Sewage treatment plant. Trustees: Wm. Bender, pres.; D. H. Jenkins, v.-pres.; B. E. Blazinski, clerk. Engineer, E. D. Otto. Consulting engineers, Pearse, Greeley & Hansen. Attorney, G. H. Bundge.

El Paso: Sanitary sewer system and treatment plant. Trustees:

Arthur Henning, pres.; J. R. McKinney, v.-pres.; John Schofield, clerk. Engineers, Holbrook, Warren & Andrew. Attorney, H. H. Baker.

Urbana-Champaign: Intercepting sewers and treatment plant. Trustees: P. W. Wright, pres.; J. C. Dodds, v.-pres.; G. H. Radebaugh, clerk. Engineers, Pearse, Greeley & Hansen. Attorney, W. G. Spurgin.

	Bloomington and Normal	*Decatur*	*Downers Grove*	*El Paso*	*Urbana-Champaign*
Area, sq.mi.	8.3	33	5.6	2.3	5.7*
Population, 1920	33,868	43,818	3,543	1,638	26,117
Year	1919	1917	1921	1919	1921
Petition to Judge	Aug, 25	July 2	March 14	July 14	Oct. 25
Boundary Appvd.	Sept. 20	July 31	April 18	Aug. 6	March 26
Election	Nov. 4	Aug. 1	May 14	Sept. 2	May 24
Trustees Apntd.	Nov. 10	Sept. 8	May 16	Sept. 15	June 10
Votes For	2,368	1,624	274	109	443
Votes Against	404	164	35	20	370
Bonds Authorized	------	$860,000	$75,000	$43,000	None
Bonds Issued	------	200,00	75,000	10,000	------
Taxes, 1920	$56,000	------	------	3,500	------
Taxes, 1921	60,000	217,506	6,750	3,000	$25,000

*Corporate area of the two cities.

THE DECATUR SANITARY DISTRICT

BY W. C. FIELD

President, Decatur Sanitary District

An act to create the Sanitary District and to provide for sewage disposal was passed by the State legislature June 22, 1917, primarily to relieve the sewage disposal situation in Decatur, which was rapidly becoming a menace to this city and adjacent territory, as well as many miles along the banks of the Sangamon River below the sewer outlets. The State Board of Health was insisting that radical changes be made from the method then in use of dumping the city sewage into the river without treatment.

An election resulted in the organization on Aug. 28, 1917, of the Sanitary District of Decatur, 33 square miles in area and including the city. As provided by law the county judge appointed three individuals to serve as the board of trustees, which was organized by the election of a president, vice-president, clerk and treasurer. An attorney was employed and all preliminary ordinances, rules and regulations were passed.

The Sanitary District is a separate municipal organization and possesses the fundamental powers of a municipality, such as the power to tax, issue bonds, contract, condemn property and police and govern the property and territory of the district. The right to issue bonds, which has been exercised by this board is made possible upon a majority of the electors voting in favor of such an issue. The entire indebtedness of the district, however, must not exceed five per cent of the valuation of the taxable property.

The Board may levy and collect taxes aside from that which is necessary to pay off the bonded indebtedness, not to exceed 0.3 per cent of the value of the taxable property, but an additional tax may be levied when authorized by the voters of the district at an election. The taxes are levied, certified, collected and enforced in the same manner and by the same officers as the state and county taxes.

The Board of Trustees meets twice each month, and special meetings are called to dispose of emergency matters. The resident engineers and attorneys for the Board attend all meetings. The Board of three is not so large as to be unwieldy, and matters of importance are thrown open for general and informal discussion among the members. All actions of the Board are by motion, resolution or ordinance.

The members of the Board are all active business men, whose time is given as a public duty to the community, the salary being $100 per annum. Politics and favoritism have no influence in the deliberations or conclusions. The business of the district is conducted as carefully and economically as that of the private companies directed by members of the Board. No excuse for being absent from a meeting is acceptable unless such member is sick or out of the city. Of the three members, Mr. Wood is president of the Decatur Bridge Co., Mr. Millikin is at the head of the Union Iron Works, and the speaker's business has made him vitally interested in sanitation matters.

Since the Board was in possession of much available information obtained by the city council during its investigations and experiments with various methods of sewage disposal, it was deemed best to confine its efforts to investigating what were considered by leading engineers as the most practical methods of sewage disposal; namely, the activated sludge method and the Imhoff tanks and sprinkling filters; the first on account of its comparative freedom from odors; the latter on account of its simplicity and economy in operating. The Board visited Milwaukee, Wis., and Champaign, Ill., where experimental plants of the activated sludge type were in operation, and also secured information from other cities using this method. It also visited the Imhoff tank and sprinkling filter plants in operation at Columbus, O.; Rochester, N. Y.; Baltimore, Md.; and Plainfield, N. J.; also the plants under construction at Chicago and Philadelphia. As a result the Board concluded to build an Imhoff tank and sprinkling filter plant to cost not less than $500,000.

In building the intercepting sewer, subsidence has been one of the important problems. Investigation disclosed that some of Decatur's streets located above the point where coal has been removed show settlement of from 12 to 18 inches. About a mile, or one-third of our intercepting sewer is subject to this condition and

may yet give trouble. The balance of the sewer, as well as the site of a treatment plant, is being protected by acquiring the coal rights underneath and for more than 100 ft. distant.

Another important power of the board of trustees of such a district is to prevent the pollution of any water from which a water supply may be obtained for any city, town or village within the district. Our Board is now confronted with this duty, as the water supply for Decatur, of some 50,000 people, is derived from a lake 14 miles long and from one to two miles wide, made possible by the building of a dam across the Sangamon River. This lake has been very popular in the city and surrounding territory, as a source of pleasure and recreation. On the other hand, duty and the sanitary engineers recommend very stringent regulations in regard to the use of the lake and shore line for fishing, boating, hunting, and bathing, and the watershed territory adjacent thereto. It will be the duty of the trustees to follow the mandate of their own judgment and that of sanitary engineers relative to these regulations.

Engineering matters and sanitary problems have been by far the greatest in importance. We believe ourselves fortunate in having the able assistance of Pearse, Greeley and Hansen, engineers of Chicago,—and particularly the services of Mr. Greeley, president of this society, as the active consulting engineer for the entire project. Our resident engineers are Mr. Hicks and Mr. Oetsel.

SANGAMON RIVER DAM AT DECATUR, ILLINOIS

BY J. ALBERT HOLMES*

The city of Decatur, Ill., is increasing its water supply by providing for the storage of about eight billion gallons. The source of supply is the Sangamon River, with a watershed above the dam of 862 square miles. The 1920 census gives the population of the city as 43,818. The present water consumption amounts to about 5,000,000 gallons per day, or 114 gallons per capita. In addition, from 4½ to 5 million gallons per day in the winter and 7 to 7½ million gallons in the summer are pumped by the Staley Company, manufacturer of starch and glucose.

The city has a pumping station and filter plant on the river bank just above the old dam, and water is lifted by two 10-inch centrifugal pumps of 11 million gallons capacity, to the settling basin of the filter plant, from which it flows by gravity back to the station pumps, which then force it into distributing mains under 80-lb. pressure. For fire service the pressure is increased to 120 lb.

The new dam is located about 1300 ft. upstream from the old one and adjacent to the settling and clear water basins of the filter

*Chief Engineer: Pearse, Greeley & Hansen, Chicago.

plant. Construction was begun in June, 1920. Excavation of puddle trenches and the driving of cut-off sheeting under the north embankment was followed by excavation from borrow pits for fill, first in the north approach to the county bridge and then the north embankment.

The major part of the earth was excavated by steam shovel and transported in drop-bottom wagons. To make the wet excavation for the spillway in the bottom land south of the river, a dragline was used. A hopper was erected in front of the mast, into which material was dumped and distributed by means of chutes and with the aid of water. In the south embankment, the puddle core was formed between earth dykes. The puddle in the north embankment was placed by sluicing from the enclosing dykes until the trench was filled and the original ground blanketed. Above this the material was dumped in layers from wagons and wet with a hose. The upper portion of the south embankment was placed in the same manner. The material is very compact in the embankments, and proved to be quite impervious under the heads to which it was subjected by the pools.

The total length of the dam is 1770 ft., with a timber and steel cut-off for 1557 ft. At the ends, under a portion of each embankment, Wakefield timber sheeting was used. Under the spillway and where the sand layer is thick, and also where driving was difficult in gravel, steel arch-web Lackawanna sheeting was used, 14 x 3/8 in., weighing 40.83 lb. per lineal foot. This was about 40 ft. long and was driven by jetting with a 2-in. nozzle at 75 lb. pressure.

The raising of the county bridge 15 ft. involved the building of new abutments and wing walls. A problem was presented in the construction of the abutments, which were to be increased in height from 29 ft. to 44 ft. Investigation of the front row of piles indicated a load of about 27 tons per pile, assuming 2 tons per square foot for the ground. The piles were short, and in the north abutment did not reach hardpan. The new work would increase the loading on these piles. To increase the stability of the abutments and wing walls, batter piles were driven under the front of the wings and 36-ft. piles, reaching to hardpan, were used under the north wing next the abutment, the new concrete of the wings and backing of both abutments being tied together with steel through the old work and above it at the corners.

Relieving platforms were adopted to relieve the pressure imposed by the new work on the 30-ft. section of abutment that included the old wall and piling at both ends of the bridge. A timber platform on piles, carrying a portion of the fill just back of the wall, reduces the pressure on the wall about one-half when placed at half height of wall. In this case the platform is slightly below half height and two feet lower than full reservoir, the object being to keep it submerged to preserve the timber. The use of the plat-

forms moves the resultant of pressures from 2 in. outside to 15 in. inside the middle third and reduces the toe pressure from 11,700 lb. to 9400 lb.; it changes an uplift of 300 lb. at the heel to a downward pressure of 2000 lb. The loading on the front row of piles is reduced from 31 to 22 tons per pile, this latter weight being less than that imposed by the old wall and fill—27 tons.

After unwatering the cofferdams, bearing piles and cut-off sheeting were driven and the bottom prepared to receive the concrete. The apron and spillway base was placed in alternate blocks, using side forms only. The spillway was placed in 18-ft. sections within a steel form.

High water flooded the coffer on Nov. 21, 1921, and enforced a ten-day delay. At this time all the apron and spillway foundations were in place and only three sections of spillway remained to be placed. When the flood had dropped sufficiently, the cofferdam was quickly unwatered. The last section of spillway was placed Dec. 6, 1921, and water admitted to the coffer Dec. 10. While work was being carried on in the north cofferdam, the river flow passed around the south end in a channel partly excavated by the dragline. Two sections of spillway were left out above the elevation 592, in that portion built in the north cofferdam, for passing the river after the closure of the south cofferdam.

At the north end of the dam are located two 9 x 14-ft. structural steel flood gates with sills at elevation 600.33, and below is a 4 x 4-ft. sluice gate with sill at 595. In the adjacent abutment is located the inlet chamber, from which the water passes to the pumping station. So long as the old dam remains in place, a depth of not less than 7.5 ft. of water will be maintained over the apron of the new dam. A fish-ladder is provided at the south end of the spillway.

The water slopes of the north and south embankments are paved with 4 in. of concrete, laid in alternate 10-ft. squares. This slab is supported against sliding by a 20-in. toe wall 4 ft. high and is underdrained by a system of gravel-filled trenches with frequent outlets at the base of the slope, over the top of the toe wall.

The work is being done under a cost-plus contract, in which the base price is $700,000, and the contractor's fee is 10 per cent. To this is added a lump sum of $20,000 for plant charges, to cover the use, rental and depreciation of machinery, tools and equipment. There is an upset or maximum price of $975,000, and a provision for adjusting the base price to the quantities actually placed at the unit prices bid, provided no changes have been made that would affect these prices.

It is provided that if the actual net cost of the work, when completed, should exceed the base value, the contractor shall be paid as his fee the sum of 10 per cent of the base value, with a deduction from this 10 per cent of 20 per cent of the amount or cost in excess of the base value, but provided that the total deduction shall

not exceed 50 per cent of the 10 per cent. Also, if the actual net cost of the work when completed shall be less than the base value, the contractor will be paid as his fee the sum of 10 per cent of the base value, with an addition thereto of 20 per cent of the difference between the actual net cost and the base value. The contractors are L. N. Cope & Son, of Decatur, Ill. The consulting engineers are Pearse, Greeley & Hansen, of Chicago, for whom the writer is chief engineer.

STORM WATER RUNOFF IN CITIES

BY CHAS. B. BURDICK

Computation of storm water runoff in the design of sewers and drains for cities is one of the engineering problems distinctly empirical in its nature. Unlike problems in statics, the solution is not mathematical. Results approximately correct are all that can be expected. The line of reasoning must connect effects in known cases, through causes, to effects in unknown cases. The great variations in runoff rates is shown clearly by curves prepared by this writer. Thus storm sewers in Baltimore appear to require about ten times the capacity deemed to be sufficient at Gary, Ind., with other cities of the middle and eastern states generally intermediate between these extremes. Such curves are still quite useful in the application of the Rational Formula to sewer design, for an approximation of the runoff must precede a calculation of the time of concentration.

Area Formulas: Early rate of runoff does not increase proportionately to the increase of area drained; that is, the unit rate from small areas exceeds that from large areas. Numerous formulas have been suggested, usually based upon rate of rainfall, area, slope and character of surface. The Hawksley formula developed for London conditions about 1857 is one of the earliest examples. The Burkli-Ziegler formula developed in Switzerland about 1880 was formerly used in this country. The McMath formula developed in the St. Louis Department of Public Works about 1887 has perhaps been more frequently used in the middle west in recent years than any other formula of this type.

For the application of the area formulas it has been the custom to modify them approximately to fit the local conditions as far as the same could be determined by an observation of the necessary capacity of works built for carrying storm water. This was accomplished by a variation in the rainfall or the surface coefficient, or the product of the two as seemed to be necessary to produce consistent results. But these formulas gave no consideration to the shape of the watershed.

Shape of Drainage Area: The heaviest downpours are of short duration. The total average rate of rainfall at a given place

rapidly decreases with the length of the storm. Thus, if a given rainstorm completely covers two watersheds of equal area, the peak of the runoff rate would be likely to be greatest where the path to the outlet of the district is the shortest or most quickly traversed. Thus, a fan-shaped district (a semi-circle) has the shortest possible time of concentration, and a long, narrow rectangle (length four times the width) the longest time, with a square district intermediate, the two latter having the main drain in the middle. The relative times of concentration and the relative peak flow rates expressed as ratios, assuming equal slopes and a typical rainfall curve, would be approximately as follows:-

Shape of District	*Relative Length of Longest Drain*	*Relative Runoff 20-min. Storm*	*Relative Runoff 60-min. Storm*
Fan-shaped	100%	100%	100%
Square	180%	75%	65%
Narrow Rectangular	280%	56%	52%

Rational Formula: It was probably recognition of the important effect of shape that led to the adoption of the so-called "Rational Formula" in the computation of storm water runoff in which the rate of runoff usually expressed in cubic ft. per second per acre is expressed in terms of

(a) The average rate of rainfall in inches per hour for the time required for every part of the district to contribute the flow to the outlet. Inches per hour is substantially cubic ft. per second per acre.

(b) An empirical coefficient covering all other variable factors having the effect of producing a result consistent with experience.

The use of this formula has been explained in engineering literature (see "American Sewerage Practice" by Metcalf & Eddy) but it is thought desirable to bring out a few new data available to the writer.

Rainfall: In some important cases it is desirable to know the rates of fall in the *greatest* storms likely to occur, as in cases that might entail great loss of life, excessive property damage, or in very costly improvements that could not be enlarged easily. In most cases of city drainage the best design is a proper balance between prospective losses and the annual interest and depreciation charges in the drainage system; thus determining the greatest storms of various durations wise to provide for. This usually results in the provision for storms likely to occur once in 10 or 20 years, or perhaps less in some cases. Numerous rainfall curves have been worked out for particular localities showing the rates of rainfall prevailing for various periods in great storms. The data are comparatively limited from which the frequency of great storms can be determined.

The latest study of this character is that made by the U. S. Hous-

ing Bureau in 1918, which summarizes all the U. S. Weather Bureau data on storms having a rate of 0.75 inches per hour or more in 23 American cities east of the Missouri River. As the report containing these data has not been printed, Table 1 has been prepared which abstracts the information. Neglecting the Pacific Coast, which is subject to special weather conditions, the area covered by these statistics indicate storm conditions rather more uniform than would be expected. Thus considering frequent storms (once in two years), five-minute storms quite generally vary from rates of 4 to 5 in. per hour; 10 minute storms appear to be just under 1 in. per hour, except along the South Atlantic and Gulf seaboard where the rates appear to be about 50 percent greater.

Considering the greater storms of less frequent occurence (once in 20 years), it is to be expected that the exceptional storms would have more than ordinary significance in a record not longer than 20 or 30 years. Such appears to be the case. In general, the 20 year storms for five minutes reach rates of 7 to 8 in. per hour regardless of locality, and 2 to 3 in. per hour for 60 minute storms occuring once in 20 years. The tabulation notes four excessive storms of five minutes' duration reaching a rate of 9.4 in. per hour at Memphis, 9.5 at Buffalo, 10.6 at St. Louis, and 9.6 at Kansas City. These places are widely scattered. Locality does not appear to be of important consideration.

The most striking feature of these data is the uniformity of rainfall conditions. It would almost seem as if the rainfall might properly be combined with time of concentration and applied to all the localities shown in the table without violence to resulting runoff. A standard rainfall curve would seem to be reasonably well applicable over a wide extent of territory. Evidently we must look elsewhere for conditions producing the great variation in runoff rates previously noted. In the Rational Formula all factors other than rainfall are combined in one coefficient. This must take into account innumerable conditions, all affecting the result to a greater or less extent.

Thus, upon a sand hill there is practically no runoff except as ground water. Even with fine sand, some top vegetation and winter conditions, a sandy locality such as northern Indiana will absorb great quantities of rainfall. The runoff is practically limited to roofs and paved areas closely adjoining the sewers. The conditions are similar in a large part of Chicago.

Another factor conduces to the low runoff in the Chicago region, the flat slopes resulting not only in sluggish gutters, but also in important surface storage which prolongs the runoff, and greatly reduces the peak. As much as an inch of water may be stored upon the surface for a fraction of an hour without great inconveniences. It gravitates to the lower places, usually permitting a pedestrain to pass dry shod, and not accumulating at suffi-

FREQUENCY AND INTENSITY OF RAINFALL RATES FOR SHORT PERIODS

Frequency		Mean Annual Rainfall Inches	Rate in Inches per Hour Occurring Once in											
			2 Years				10 Years				20 Years			
Periods in Minutes			5	10	30	60	5	10	30	60	5	10	30	60
STATION	YEARS													
Boston	1897–1916	45	3.4	2.4	1.4	.9	5.3	4.4	2.6	1.6	6.6	5.4	2.9	1.8
New York	1896–1916	45	4.1	3.2	1.6	.6	7.4	5.8	3.2	1.7	8.2	7.2	4.1	2.1
Albany	1897–1916	--	4.1	3.2	.7	--	6.6	5.0	2.4	1.4	7.0	5.4	3.3	1.8
Philadelphia	1881–1916	42	4.8	3.8	2.0	.7	6.9	5.5	3.8	2.5	7.7	5.9	4.1	3.2
Washington	1881–1916	43	4.4	3.6	2.0	.9	6.5	5.6	3.5	2.3	7.4	6.5	4.0	2.5
Norfolk, Va.	1896–1916	--	4.8	4.0	2.2	.9	6.7	5.5	3.3	1.8	7.2	5.9	3.4	1.9
Savannah	1889–1916	--	4.9	4.0	2.7	1.5	7.0	5.9	3.6	2.2	7.7	6.3	3.7	2.4
Atlanta	1897–1916	--	4.9	3.8	2.4	.8	7.1	5.4	3.8	2.2	8.2	6.0	4.3	2.4
Montgomery	1897–1916	53	5.4	4.4	2.6	1.4	6.5	6.0	4.2	2.8	6.7	6.2	5.0	3.5
New Orleans	1896–1916	60	6.2	5.2	3.2	1.7	7.2	6.8	4.2	2.6	7.6	7.2	4.7	2.8
Knoxville, T.	1896–1916	--	4.2	3.3	1.6	--	5.5	4.9	3.1	2.1	5.8	5.3	3.4	2.4
Memphis	1897–1916	--	4.0	3.3	1.9	1.1	5.4	4.7	2.5	1.7	*9.4	5.5	2.9	1.9
Louisville	1896–1916	47	3.8	3.0	1.7	.9	6.3	5.1	3.0	2.0	7.2	6.0	3.5	2.7
Pittsburgh	1896–1916	37	3.8	3.0	2.1	--	6.2	4.8	2.6	1.4	6.7	5.4	2.9	1.6
Buffalo	1897–1916	--	3.8	2.9	1.3	--	5.0	4.1	4.4	--	*9.5	4.2	2.5	--
Detroit	1896–1916	33	4.3	3.4	1.5	--	5.7	4.6	2.8	2.0	6.1	4.7	3.0	2.3
Chicago	1896–1916	34	3.8	2.9	1.7	.8	6.7	5.2	2.8	1.5	7.0	5.9	3.0	1.7
Duluth	1897–1916	31	4.2	3.0	1.4	.8	5.5	5.0	2.8	1.7	6.2	5.9	3.3	2.3
St. Paul	1896–1917	28	4.6	3.6	2.0	.8	6.2	4.9	3.2	2.1	7.0	5.4	4.0	2.6
St. Louis	1889–1916	41	4.5	3.5	1.7	.9	7.7	5.4	3.0	2.0	*10.6	6.0	3.4	3.0
Kansas City	1896–1916	--	4.5	3.8	2.5	1.3	7.7	6.4	4.4	3.0	*9.6	6.7	6.0	4.4
Seattle	---- ----	--	--	--	--	--	1.6	1.3	1.1	--	--	--	--	--
San Francisco	1898–1916	23	--	--	--	--	1.9	1.9	--	--	3.0	2.5	--	--

*Exceptional Storms.

cient depth to enter cellars. On the other hand, the steep clay hills in some localities produce conditions comparable to a roof, particularly under the conditions of frozen ground and dead vegetation; and when the ground has been thoroughly saturated previous to a heavy downpour.

Rolling ground places an added burden upon the sewers. Upon flat land a surface variation of 6 in. might readily store an inch of water, producing a depth not to exceed two or three inches at any place, and leaving most of the ground uncovered. In a hilly or rolling city with an insufficient drain the water might accumulate to a depth of several feet in the low places, doing great damage.

Experimental Data: The value of experimental data has frequently been emphasized and city engineers are studying their storm water sewer systems to obtain information that will permit a more accurate determination of the factors for use in the extension of their sewer systems. Data in reference to floods are difficult of determination because the rare flood seldom occurs, the opportunity to observe it is soon past, and the opportunity for measurements is lost unless preparation has been made. These data sometimes are discouraging because it is a well observed fact that storms of given magnitude as observed by ordinary rain gages are productive of results differing widely. This may often be accounted for by the fact that previous rainfall conditions, the condition of the ground, and other varying factors have a very large effect.

Further, it must be recognized that a standard rainfall curve is not perfectly representative of any storm. No rainfall is uniform. The maximum may occur at any time during a downpour, and it may travel across a watershed in a way to increase or to diminish the floodway. Formulas for runoff take no account of storage and the storage in the sewer itself has an important effect upon the rate of runoff for short periods, to say nothing of the storage on the ground. This factor varies tremendously under different circumstances, even on the same watershed. A single rain gage may give a very imperfect record of rainfall. Mr. W. W. Horner, engineer of public works at St. Louis, has established several self-recording rain gages scattered throughout the city in order to observe the extent of varying rates of precipitation. Many of the excessive rates at particular places are likely to be attributed to local conditions peculiar to that place, when as a matter of fact such rates may not be peculiar to the locality at all, but chance has so placed a rain gage that the occurence is observed. Many short storms fail to touch a rain gage.

Circumstantial Evidence: To the engineer of limited experience it often seems that the factors in our runoff formulas vary so widely as to produce undependable results. To a large extent these variations can be harmonized by making the fullest use of local data. In fact, the local data should have the greater weight

in the design of storm water sewers. Theory should only be utilized so far as is necessary to properly apply the information to areas of other sizes, shape and surface topography.

As a final word, let it be emphasized that storm water runoff in cities is a local problem and that it must be approached from a knowledge of floods in the locality. The correct application of theory is necessary to success, but it is not and probably never will be possible to disregard the local data.

REPORT OF SEWERAGE SECTION

1. The following is a list of sewerage works, the plans for which have been examined by the State Department of Health in 1921. Although this list is not indicative of the work actually performed during the past year, in future years the comparison of similar reports will indicate the progress of sewerage work. It is difficult to gather accurate data showing the amount of work actually performed.

Size of Pipe	*Completed or Under Construction, Miles*	*Contemplated Miles*
6 to 24-in.	37.82	63.09
27 to 45-in.	1.85	4.42
54-in.	0.09	----
48 to 60-in.	----	2.75
82-in.	----	0.20
99-in.	----	0.33
Miles of 6-in. size	0.94	0.25
Capacity of Plants:		
Imhoff settling tanks, gals.	6 of 220,100	11 of 164,600
Secondary settling tanks, gals.	1 of 53,500	1 of 1,650
Trickling filters, acres	2 of 0.311	----------
Sprinkling filters, acres	----------	5 of 0.627
Septic tanks, gals.	1 of 700	13 of 228,800
Sand filters, acres	1 of 0.73	----------

2. The past year has been marked by several steps in the movement for better, more simple and less expensive plumbing. The most significant was the appointment, by the Secretary of Commerce, Mr. H. C. Hoover, of a national committee to prepare a standard plumbing code; Prof. G. C. Whipple, of Cambridge, Mass., is chairman. On Jan. 13, 1920, there was submitted to the Commissioner of Public Health of Massachusetts, a report of the special plumbing board on the revision and codification of the municipal plumbing codes in the state. In Feb. 1919, the University of Illi-

nois revived its investigations of plumbing, and research in simplified plumbing equipments is now being conducted. The Illinois Master Plumbing Association is discussing the subject.

This subject should be discussed by the Illinois Society of Engineers because plumbing is of interest to sanitary engineers, a recognized division of the Society membership. It is therefore recommended that a special committee of 3 members be appointed, to report at the next annual meeting on the advisability of revising and codifying municipal plumbing codes, in order to promote simplicity and uniformity in systems of plumbing. The report should contain drafts of such legislation, if any, as the committee may deem desirable, with recommendations for procedure towards securing the passage of the proposed legislation, or the perfection by further investigation and cooperation with other interested organizations.

3. In reviewing plans for sewerage construction the engineer is struck by the lack of uniformity of method of expressing conventions, in design, and in results. Sewer profiles for similar conditions will be drawn with different exaggerations of vertical scales. Slopes, cuts, stationing and other details will be expressed in different ways. Different assumptions will be made concerning minimum or maximum permissible grades; size of pipe; depth of cover; methods of computing run-off, etc. After a sewer system has been constructed or a treatment plant has been put into operation, or a pumping station has been started, the designing engineer drops the matter, and the village constable, or the country surveyor, or the street sup't. becomes the operating official in the smaller cities. It is therefore recommended that: a committee be appointed to present at the next annual meeting tentative sets of (a), standards for sewerage plans, (b), standard methods for sewerage design, (c), rules for the operation of small sewage treatment plants.

4. Under the present system of state supervision and inspection of sewerage designs, there is a conflict and overlapping of authority between the State Board of Health and the State Division of Waterways. Any added authority should be carefully studied from the experience in other states before it is given by the legislature. It is therefore recommended that the legislative committee be directed to prepare and present at the next annual meeting a draft of a bill to alleviate these conditions.

The State Water Survey, the Department of Farm Mechanics and the Department of Municipal and Sanitary Engineering at the State University are cooperating in the design, construction, and operation of a sewage testing station in Urbana, for the purpose of investigating problems in sewerage and sewage treatment. Suggestions of problems requiring investigation will be gladly received.

W. S. SHIELDS, Chm., H. E. BABBITT, PAUL HANSEN,

Your Committee has studied the Local Improvement Act with a view to suggesting improvements or revisions. Special assessment laws of other states have been studied. Many of them have excellent provisions which could well be incorporated in our laws. On the other hand, each law by itself apparently has as many defects as our own. Since it would be extremely difficult, if not impossible, to repeal our existing law and substitute a new one, any improvement must be through amendments of existing sections, or additions thereto. The 52nd General Assembly made several excellent amendments to this act. The following sections are of particular interest to engineers:-

(1) Not necessary to publish plans on improvements of over $100,000.

(33b) Provides for tax levy of not to exceed two mills on the dollar in towns between 2,500 and 200,000, for payment of public benefits on special assessments.

(42) Raise rate of interest to 6%.

(76a) Surety bond of successful bidder reduced to one-third amount of bid. Formerly a sum equal to amount of bid.

There are a few specially weak sections deserving of correction. Section 87 provides for disposing of the bonds at par. This has resulted in our current practice of paying the contractor in bonds and leaving the scale of bonds to him. It follows that a contractor to bid on work must be something of a financier. Many contractors who would gladly bid on public work on a cash payment basis, are discouraged and prevented from bidding by this unfortunate section. We recommend the section to be changed to allow towns to advertise and sell bonds at the current market price in advance of letting the contract. In addition to the benefit to contractors, this would also direct the attention of the city officials to the weakness of these bonds and their unattractiveness to the investing public. We could hope that they would seek to remedy this condition by using great care in paying principal and interest promptly, and otherwise adding to the attractiveness and safety of the bonds.

Several states provide in their special assessment laws that the municipality issuing special assessment paper shall guarantee the payment of same. We strongly urge that this be provided in Illinois. It would immediately cause these bonds to sell on a 4% to 5% basis instead of a 6% to 10% basis, as at present. While this would entail some expenditure from the general funds of a town, it would net a profit to every town in the state.

Every engineer who has worked with this law is familiar with Section 94 providing 6% for payment of lawful expenses, as given below. We set out below an estimate of the costs of the various items enumerated. We have attempted to put down typical costs of an average improvement and make no attempt to criticize the

various items. The percentages might be reduced somewhat on a large contract of a simple design. On the other hand, on many small jobs the engineer's fee is or should be more than 5%. This is particularly true of sewage disposal plants or water purification plants, which require a considerable amount of time for design and drafting of plans.

	Per Cent of Cost of Job
Engineering, including preliminary services, plans, specifications and superintendence	5%
Inspection and tests	1%
Attorney's fee	2%
Salaries of Board, making and levying assessments, letting contract, advertisements, court costs, etc.	2%
Total Lawful Expenses	10%

We believe it would be a material benefit to engineers and the public as well to increase the amount which can be spent for lawful expenses. The change of the statute will not increase these costs. It would simply allow them to be shown openly on the estimate. We recommend that this figure be raised to 10%, or possibly, 12%. We further recommend that a strong committee be appointed to draft this and other necessary amendments and present them to the next General Assembly.

C. DeLeuw, F. A. Windes

SUGGESTED CHANGES IN SPECIAL ASSESSMENT PROCEEDINGS

1. For levying and collecting the assessment, 6 per cent is often too low. It should be variable, based on an estimate, same as the cost of the work.

2. Time warrants should bear interest at same rate as bonds, as interest on total amount is being collected from the property owners. Time warrants are not mentioned in the law, and there is some difference of opinion among attorneys as to the legality of paying interest thereon.

3. The law should be clarified as to the power of municipalities to levy against park districts for public improvements. At present, our attorney holds that we have no power to assess park property for any street improvement, although this has been done in the past. This means that Park Boards may, if they are so disposed, escape paying for improvements, which are a direct benefit to their property, such as water mains and sewers. There is some doubt as to pavements.

4. The Revenue Act, as amended at the last session of the legislature to permit a levy of two (2) mills for public benefits, should be amended to allow a levy for public benefits, equal to the public benefits *assessed* and payable in that year. The benefit to the public should govern, not an arbitrary amount fixed by statute.

THE EDUCATION OF THE SURVEYOR

BY THOMAS J. MITCHELL

The engineering college of the University of Michigan has decided that the proper schooling of the surveyor requires much more

than the time alloted to surveying in the regular civil engineering curriculum. With the sanction of the board of regents, the college has established a separate rate diploma department of geodesy and surveying. This department was authorized Dec. 9, 1921 and it is expected to function with the beginning of the next college year.

When courses in engineering were introduced into the universities they were in a large measure surveying. During the period of slow growth the teachers of engineering tended to become specialized along some particular line and this was reflected in the curricula expansions. In these pioneer days of the engineering profession, the opening of many diversified fields and their rapidity of growth made surveying (laboring under the handicap of the public land survey policy of the Federal Government) static by comparison. As a consequence, the tendency was a gradual growth away from surveying, and its practice was left to students of civil engineering who entered the field after graduation. The science of surveying depends very largely upon a complete mastery of fundamentals. As the field of the civil engineer broadened and the universities attempted to keep abreast, fundamentals were sacrificed for more technical and specialized courses so that the foundations of surveying were undermined. As a consequence, instruction in the definite field of surveying has been almost entirely neglected by engineering schools. It was with the idea of filling this gap that the Department of Geodesy and Surveying was organized.

When we compare American with European practice, we become impressed with the gap that our universities have allowed to develop. In almost every civilized country surveying in its broadest significance is considered an important and high class profession interested in the application of science to its problems. In many places in Europe separate schools are maintained for the study and research of geodesy, a branch of surveying. Apparently the European idea is that surveying is a separate profession not intimately connected with engineering, but that its practitioners rank equal to or higher than engineers.

The present demands for men with such a training as it is purposed to give, are many and definite. At present the engineering college of the University of Michigan is teaching chiefly only such surveying as is directly applicable to civil engineering problems; that is, surveys preliminary to construction. The large field of cadastral or land surveying is barely touched upon. But Massachusetts is engaged in a re-survey and some counties in Michigan are planning re-surveys. The work of the General Land Office has been completely reformed. There is a demand for men qualified by training to assume leadership. The science of geodesy has been largely confined to such federal departments as were able to train their own men. Now many of our cities have reached such a size that surveys on plane coordinates are inadequate and mislead-

ing. Business interests are yearly becoming more insistent in their demands for complete topographic maps of the nation. It will be necessary to train men to occupy this field and this training seems to be a public service obligatory on the universities.

The scientific side to this training must be mentioned. Take the field of astronomy, for instance. A perusal of the university training of the famous astronomers of our time will show that many of them started as engineers. The engineering schools are not turning out such men today. It is expected that a course based largely on fundamental sciences will again start some men on a scientific career. In various legal controversies relating to property boundaries, both land and riparian, the public needs men who besides qualifying in technical knowledge have a grasp of the legal principles involved. This, the course in surveying will attempt to give.

The course of study for the Department of Geodesy and Surveying in the University of Michigan is still in the tentative stage. At present it will be a four-year course, with elections for a fifth year, built first and foremost upon a thorough drill in the fundamentals. Such courses as are now available in the engineering college will be used. Algebra, analytic geometry, differential and integral calculus will be required in mathematics. The present engineering courses in modern languages, chemistry, physics, drawing and geology will be given. The work in English and astronomy will be increased. These courses will occupy all of the first two years and part of the third. To the surveyor, least squares and the theory of errors is indispensible. This will be given in the junior year. There will be two courses in hydraulics, and the fundamentals of theory and design of structures. Courses in steam and gasoline engines and electrical machinery will be distributed between the third and fourth years. The elements of surveying will be taught in the junior year. The summer camp following will serve as a laboratory for practice in these fundamentals.

In the senior year, advanced surveying, consisting of boundary surveying, municipal surveying, camera and aeroplane surveying, will be taught. Throughout the course, the application of geodesy to the various branches of surveying will be given. So that the graduates will have a good working knowledge of it, and for those desiring to specialize in the science, a graduate year will be necessary. A surveyor should be familiar with the law and court decisions governing property law and such acts as the Torrens Law. Courses will be designed to supply this need. Field men should know the various kinds of trees they encounter, and this necessitates a short course in forestry. In all his acts a surveyor is in very close touch with the public, therefore he should have some instruction in public speaking.

Already demands for special short courses have been made by practicing surveyors. The details for these have not been worked

out, except that any demand will be met and short courses will be given both on the campus and at the summer camp. The department will give such courses in surveying as the various departments of the engineering college desire. The University of Michigan is the first college to give a degree in geodesy and surveying.

SURVEYING INSTRUCTION AT PURDUE UNIVERSITY

BY G. E. LOMMEL
Assistant Professor of Topographical Engineering

Three different classes are now receiving instruction in surveying. The sophomore civil engineers are assigned to two semesters' work and report to the surveying department for three-hour periods each week. Following the second semester, the sophomores attend an eight-week civil engineering camp. The sophomore chemical engineers receive instruction in elementary surveying for one semester and report two hours each week. In the freshman engineering problems course, instruction in map reading is conducted by the surveying department.

This present order will be changed next semester, and the new outline provides for a course in plane surveying to be administered to freshman civil engineers during the second semester. Following this, the civils will attend camp for eight weeks and will receive additional instruction in surveying during the first semester of their sophomore year. The chemical and freshman engineering problems courses will be continued and a short course offered to senior mechanicals and electricals. This short course will include elementary exercises with the transit and level, paying particular attention to mechanical and electrical engineering practice.

The reasons for the change from sophomore civil surveying to surveying for freshmen civils are that students will come in contact earlier in their course with work which is more closely allied to civil engineering than most subjects included in their present first year course of study, and opportunity will be afforded for more and better summer employment during sophomore and junior vacations. It is the intention of the surveying department to prepare the freshmen for surveying camp work by covering the usual ground in the use and manipulation of the tape, level and transit. Field problems will be assigned and as much field work done as weather conditions permit. Calculations and drafting problems related to the field practice will be included. At the camp, more extensive problems will be assigned and the students trained not only in mechanical manipulation of instruments, but also in ability to attack original problems and solve them in the right way. The first semester of the sophomore year will be devoted to geodesy, engineering astronomy and advanced curve work.

Three features of interest in our work are: 1, Cooperation

with the military department; 2, job sheet method of instruction in the freshmen engineering problems course, and, 3, civil engineering camp. The R. O. T. C. unit at Purdue is a field artillery unit. A part of their instruction is map sketching. In order to make the military maps of real value and in order to make it possible to check these field maps, the surveying department is utilizing their students and equipment for the establishment of control traverses and levels. Last fall, horizontal and vertical control was established over a tract of about 1200 acres, the military department providing truck transportation for students and equipment.

The results of this work were decidedly satisfactory. Before the first job of chaining the lines in the several traverses was begun, the whole layout was explained and the reasons for careful work made apparent. Realizing the practical value of all of their chaining and leveling and part of their transit practice, the students were more keen in their desire to get good values and the natural results were good closures in the traverses and level circuits. Competition was stimulated by a daily posting of results and comparison with other parties running the same circuits. The average error of closure for the three transit traverses was about 1 in 11,000. The average error for the three level circuits was about 0.04 per mile of line. The areas controlled are fairly rough, the maximum difference in elevation being 107 ft.

The plan of study for all freshmen in the engineering schools provides for a course called engineering problems. This course, supervised by the Dean of engineering consists of a series of projects covering the various phases of civil, electrical and mechanical engineering. The whole freshmen class is divided into three groups and these report to the various departments for one three-hour period each week. The projects are presented in the form of maps or drawings accompanied by a list of questions which will develop gradually in the student mind logical methods of analyzing engineering problems. They give the student definite ideas concerning the various courses offered by the engineering schools and consequently the final choice of civil, electrical or mechanical engineering is made with a better understanding.

The civil engineering camp is held at a location remote from the University. The problem of finding a good site is a real one. Rugged topography, accessibility from the standpoint of both supplies and equipment and recreational facilities are ideal conditions attending the site. Areas of from 1000 to 2000 acres which fill these requirements are scarce, but we hope to be able to establish our camp on our own land within the State of Indiana. Camp activities begin about a month before the end of the second semester. The students who are to attend camp hold a meeting and elect men to serve on the student committees of which there are four: conduct, sanitation, entertainment and commissary. The government

of the camp is vested in the chairman of these committees, together with the camp faculty. Field parties of six men are formed. The organizations are perfected by the students themselves.

About a week before the departure for camp, mimeographed notes are distributed covering camp problems, general rules and regulations, calendar and daily program. Students are required to deposit with the university bursar an amount sufficient to cover their traveling expenses, housing and food. The university hires cooks and the purchase and preparation of the food is in charge of a member of the camp faculty.

Camp work begins on Monday morning following the end of the second semester. Problems are assigned by number referring to the camp notes, and each individual is assigned to perform a certain part of the work under the direction of an assigned chief of party. The field work is done, computations and drafting all finished before the party leaves camp. The problems assigned cover location surveys, preliminary and final, topographic surveys, hydrographic surveys, triangulation, base line measurement and determination of latitude and azimuth.

BATES EXPERIMENTAL ROAD

BY CLIFFORD OLDER
Chief Highway Engineer of Illinois

Early in 1920, Governor Frank O. Lowden, in conference with Frank I. Bennett, Director of the Department of Public Works and Buildings, S. E. Bradt, State Superintendent of Highways, and the writer, decided that the State of Illinois was justified in undertaking the construction of an experimental road of unprecedented magnitude. This decision was based on the fact that Illinois then had in contemplation the expenditure of possibly $100,000,000 in a road improvement program. The result was the construction of the Bates experimental road, started in 1920 and finished in 1921. The investigations in connection therewith were heartily endorsed by Governor Small. Since the completion of the road an average of ten engineers have been occupied in research work.

Subgrade Moisture.—Subgrade samples for the determination of moisture content have been collected periodically from several hundred stations located along this road and along about 60 miles of paved highway adjacent to Springfield. The soil is clay. It soon developed that the moisture content in proximity to edges and cracks was at no time materially different from that observed elsewhere. At a point where a tile drain with cinder backfill was laid 30 in. below each edge of the pavement for 200 ft. the moisture samples show no variation from those obtained elsewhere.

To determine the possible rate of saturation of the subgrade

from the edges to the center, a trench was cut about one foot from the edge of the pavement and kept filled with water for three weeks. The moisture content of the subgrade at sampling stations only 30 in. from the edge of the trench showed no variation from that at other points under the pavement. From the results of freezing tests, it seems probable that although a clay subgrade may resist saturation from an occasional rainfall, yet the same soil may quickly become saturated after a freeze.

Subgrade Bearing Power.—Believing that soils might behave differently under repeated loads as compared with loads applied but once, an apparatus was perfected by means of which loads up to 50 lb. per sq.in. could be repeated indefinitely on subgrade soils in place. The tests point strongly to the conclusion that a soil having a given moisture content may under repeated loads have a fairly definite elastic limit. For example: on a clay subgrade a load of 5 lb. per sq.in. was applied approximately 1000 times. After the initial deformation, caused by the first few applications of the load, subsequent applications produced a definite deformation under each repetition with complete recovery as the load was released. The load was then increased to 25 lb. with the result that progressive deformation continued until a total penetration of 0.25 in. occurred, when the test was discontinued.

The general behavior of subgrade soils as determined on small areas by this machine was closely confirmed by loading concrete slabs having areas of several square feet, which were cast on the same subgrade. These slabs were loaded repeatedly by means of a hydraulic jack. Even in the case of these slabs which were presumably in perfect contact with the undisturbed subgrade the first few light loads caused permanent depressions. It remains to be determined whether or not a subgrade soil at all seasons of the year, or at seasons when the greatest degree of saturation prevails, may be counted upon to exhibit elastic resistance to deformation when subjected to pressures as great as the lowest that may practically be obtained with economic pavement designs. It is certain that this resistance for the Illinois corn belt soil, containing at times 40 per cent moisture, is very low, probably less than 1 lb. per sq.in.

Subgrade Uniformity.—In the Bates road were installed many subgrade cylinders each having a brass disk in contact with the subgrade and a reference plug screwed in the cylinder in such a manner that measurements taken from the plug to the disk would show the relative position of the subgrade and the pavement slab. (see Public Roads, Vol. 4, No. 5). These observations show a periodic separation of the pavement slab and the subgrade due to the warping of the slab under temperature changes. They show also erratic variations due probably to uneven settlement of the subgrade.

Frost Action.—Precise levels taken from bench marks care-

fully protected from frost action, showed a heaving or lifting of the edges of the slab throughout the entire length of the road, at a much more rapid rate at the center. Where a longitudinal joint was provided, the edges of the slabs lifted an average of ¾-in.; during the same period the center lifted but about ¼-in. Many sections not provided with longitudinal joints showed approximately the same behavior, and when examined in the spring were found to be cracked longitudinally. A few sections lifted at the edges about ¾-in. and at the center about ½ in.; these sections showed no discernible longitudinal cracks in the spring. As no loads were permitted on the road during this period, it is evident that the longitudinal cracks were caused by the breaking of the slab under dead load while supported at or near the edges only. If the heaving of the soil due to freezing is universally more rapid under the edges of the pavement than elsewhere, it would appear impossible to avoid the longitudinal breaking of wide slabs where freezing temperatures occur, especially under heavy traffic. Mathematical analyses indicate that it is likely to be economically impracticable to design wide slabs of sufficient strength to avoid breaking longitudinally when the edges only are supported. Hence the present Illinois design provides for a longitudinal joint in order that erratic longitudinal cracks may be avoided as far as possible.

Temperature Effects.—The lateral and longitudinal expansion of a pavement slab, due to temperature and moisture changes, is well appreciated. It is doubtful if lateral contraction or expansion is responsible for longitudinal cracks. It is more probable that such cracks are due to freezing subgrades or perhaps to conditions of support caused by the warping of the slab. It seems likely that contraction due to temperature or moisture changes accounts for at least the first transverse cracks that appear in all concrete slabs.

By means of the brass disks of subgrade cylinders located in a row across the pavement slab, the relative movement of the slab and the subgrade was confirmed. In many cases these measurements indicated positively that the downward curling of the edges during the day lifts the center of an unbroken slab entirely free from the subgrade near the center. They indicate also a permanent depression of the subgrade at the edges of the pavement under this condition, although a partial recovery occurs as the edges curl up at night. The warping phenomenon is caused by the more rapid heating and cooling and consequent expansion and contraction of the upper layers of the slab. It occurs much more rapidly on clear, sunny days. Monolithic brick pavements exhibit practically the same degree of warping as concrete slabs. The effect is much reduced when a bituminous concrete surface is applied and it is similarly reduced when a brick wearing surface having a bituminous joint filler is used on a concrete base. There is but slight warping of slabs having plastic surfacing materials of considerable thick-

ness. Attention is called to the comparatively small warping of the concrete slab having a longitudinal joint.

It is evident that the warping of rigid slabs away from the subgrade provides open channels for the free passage of surface water to the subgrade. This water from rains or melting snow finds its way under the edges of a slab as it curls up in the early part of the night and later freezes, thus forming a higher support for the edges and causing an excessive lifting of the entire slab the next day unless it breaks longitudinally under its own weight.

Impact.—Specifications of the Illinois Division of Highways provide that the variation in elevation of the surface of concrete pavements shall not exceed ¼-in. Some difficulty has been encountered in securing this degree of smoothness, especially on grades of more than 2 or 3% and on curves. However, the variations are not abrupt and a constant improvement is being obtained. The variation may be reduced materially by more careful construction methods, perhaps aided by hitherto untried equipment. By careful maintenance methods the application of crack filler can easily be handled in such a manner as to avoid any material differences in elevation from this source.

Some of our data indicate that possibly this matter is not of extreme importance. For example, Ames dials have been placed so as to read deflections of the pavement slab, and trucks were operated close to these dials at speeds up to 20 miles per hour. Yet no movement of the hand of the dial has indicated more than a gradual and steady application and release of the load as the truck passed.

All Cracks Not Serious.—It may be assumed that a pavement need not be so designed as to avoid all possible cracks or even all load breaks. The usefulness of a pavement is destroyed only when it becomes so broken or disintegrated that it no longer affords a smooth and comparatively unyielding surface. Transverse cracks or joints in rigid pavement slabs may be accepted as inevitable. Illinois for about six years has not provided for transverse joints; yet possibly with the exception of a few roads carrying very heavy trucks and in one unexplained instance, transverse cracks do not average less than about 30 feet apart. This average covers pavements more than three years old. On two stretches of concrete roads in Cook County, subjected to very heavy truck traffic, transverse cracks are much more frequent, regardless of the character of the subgrade soil or drainage, and longitudinal cracks occur throughout. The frequency of the cracks in these sections may be due to the existence at one time or another of comparatively large areas where the subgrade was not in contact with the slab.

Allowance Stress in Plain Concrete.— It becomes of great importance to determine what may be a safe working load for plain concrete in tension. An apparatus was outlined by the writer and

built in accordance with designs made by Mr. Clemmer, our testing engineer, for determining the effect of repeated loads on the transverse strength of plain concrete beams. The results indicate that plain concrete in transverse bending may be able to withstand an indefinite number of repeated loads provided the stress is something less than 50% of the modulus of rupture. We hope soon to be able to say what a safe value for this per cent should be.

Design of Rigid Pavements.—Until exhausive investigations can be made to determine the economic truck unit, we are faced with the problem of controlling maximum wheel loads by legislation based upon arbitrary judgment. The Illinois law provides for a maximum axle load of 16,000 lb. This may be assumed to correspond with an 8000-lb. wheel load. It is our observation that on trunk line roads in the near future great numbers of trucks, loaded to the limit prescribed by law, may be expected.

In the light of what we believe to be conclusive evidence that an uncovered rigid slab may become warped by temperature effects so that it will, for from 8 to 12 hours out of every 24, be completely unsupported along the edges by even the best of subgrades, and considering the probability that at least on clay subgrades at certain seasons of the year the soil may have an exceedingly low supporting capacity, and further considering the fact that during the period of greatest subgrade saturation which no doubt occurs immediately upon the thawing out of the ground in the spring when low temperatures prevail, the cracks are open to the maximum amount, *it would seem that to resist local breaks it is necessary to design the corners of the pavement as unsupported cantilevers.* Unbroken edges are far less susceptible to traffic breaks than corners.

In order that all possible corners might be taken care of the position of the longitudinal crack should be controlled by constructing a longitudinal joint and the adjacent slabs held in close contact by transverse tie bars. The interior corners, being held in close contact along the longitudinal joint by the transverse tie bars, should be fully as safe as the edge corners. The shear bars along the edges should also be continuous in order to take care of the corners formed by transverse cracks regardless of their position.

The Effect of Intensity of Traffic.—It is evident that aside from traffic accomodation, roadways of a width such that under normal traffic conditions frequent turning off and on the slab by heavy trucks may be avoided, are much to be desired. The fatigue experiments indicate clearly that the life of a concrete slab may be long or short depending upon the frequency of the passage of loads great enough to stress the concrete up to 50 per cent or more of its modulus of rupture. For example, a few thousand repetitions of loads sufficient to stress the concrete up to 60 per cent of its modulus of rupture cause failure. If on a given road about 5000 loads suf-

ficient to stress the concrete to this figure occur during the first month's use, the slab in all probability would fail the first month. If the same number of equal loads should not occur for several years it is possible that the life of the pavement might be indefinite, as undoubtedly the modulus of rupture would have materially increased.

In the light of the investigations showing the marked warping of concrete and monolithic brick pavements, due to temperature changes, it is the writer's judgment that such slabs should be designed for a corner strength sufficient to reduce the fibre stress to a safe limit regardless of the character of the subgrade. It is true that the higher the supporting power of the subgrade, the lower will be the fibre stress of the slab under day time applications of loads. Nevertheless, the warping of the edges and corners upward at night is so great that the best subgrades would be of little value in reducing the slab stress under night applications of maximum loads. Good subgrades may therefore materially prolong the life of a pavement by reducing the frequency of the occurrence of critical stresses. In such case, however, the occurrence of load breaks would be merely a matter of the intensity of traffic at night and during periods when the pavement is least supported by the subgrade unless the slab is designed for such critical conditions.

REPORT OF COMMITTEE ON COOPERATION

At the suggestion of the president and the Executive Committee, your committee has directed its attention to the subject of the licensing of engineers and submits a report with recommendations for specific action. The subject has long been occupying the thoughts of engineers and space in the engineering press. Agitation has culminated in action which has resulted in the passage of laws in many states, and in recommendations from committees in many societies. In September, 1921, there were *seven* states remaining where some form of activity towards the licensing of engineers had NOT taken definite form. Among engineering societies which have taken action are: American Society of Civil Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Institute of Mining Engineers, American Institute of Consulting Engineers, American Association of Engineers, and Society of Naval Architects and Marine Engineers.

The laws in different states are not the same. They may be classified into two general types: a comprehensive law including provision for all classes of engineers; a restrictive law excluding many branches of the profession. A hard and fast line cannot be drawn between these two classifications, but in general, those states

having comprehensive laws are: Colorado, Iowa, Minnesota, Tennessee, Louisiana, New Jersey, Florida, Indiana, North Carolina, Virginia, Oregon, Arizona, Michigan, New York, West Virginia, Pennsylvania. The states having restrictive laws are: Idaho, Wyoming, California and Illinois. Variations between laws in different states, injustices in and between states, misunderstandings between engineers, and expense to the profession, have led practically all worth-while engineering societies to take some action.

We are interested, principally, in the effect of the present Illinois law on Illinois engineers. The history of the licensing of engineers in Illinois is not a credit to the movement. The first law passed in Illinois restricted the construction of anything having foundation, walls and a roof to architects. Engineers found themselves working for architects, and as a result commenced agitation which was successful in obtaining legislation known as the Structural Engineers License Law, which admits structural engineers, with architects, to the design of structures with foundation, walls and roof. It does not include similar benefits for other classes of engineers. In fact it works some hardship on them, necessitating their qualifying as structural engineers to perform work not necessarily within the province of the structural engineer. Incidentally this bill took over $40,000 from the engineering profession of the state. Other classes of engineers in Illinois also find difficulty when attempting to practice in other states because of the restrictive and discriminatory nature of the Illinois law. Full reciprocity between states cannot exist under the present law, and the Illinois engineer is obliged to take examinations, or otherwise to qualify under the law of a neighboring state.

Because of the present satisfactory condition of affairs in Illinois, from the viewpoint of the Structural Engineer, it is not probable that active support can be expected from him in this movement. Because of the manifest justice of the claims from other engineers for protection and because of the benefit to the public from the protection afforded to it by the licensing of all engineers, it is not probable that active antagonism will be met from any engineering organization, provided the movement for a revision of the present license law were in the direction of a comprehensive law affecting all engineers, and it were so written as to allow better reciprocity between this and other states.

In view of the facts above stated and the situation resulting from their existence, it is recommended that the committee on legislation be directed to prepare a draft of a proposed engineer's license law which shall include licensing for all engineers; shall provide for adequate reciprocity between states; and shall include such other features as may seem desirable.

H. E. BABBITT, Chairman, W. W. DEBERARD, W. D. GERBER

NOTE—Since many societies are investigating licensing laws, it

has not been considered desirable to carry out the detail suggestions of the Cooperation Committee in regard to such a law, as this would involve duplication of other independent investigations. For this reason the program outlined by this committee is omitted.

RESOURCES OF CONCRETE AGGREGATE IN ILLINOIS

BY H. F. CLEMMER

Engineer of Tests, State Highway Commission, Springfield, Ill.

A thorough knowledge of all available deposits of materials would do much to bring about closer estimates and a more economical construction of highways. A knowledge of freight rates also is necessary in order to get materials at minimum cost. It is often cheaper to get materials from long distances than from pits or quarries a few miles from the job, as switching charges are in many cases prohibitive. Haul by teams or trucks has long been a source of great expense but with the increasing mileage of pavements there is bound to come a lowering in cost of such transportation.

Many rock ledges, gravel beds and sand banks contain some materials of satisfactory quality. It is generally conceded that if the 1922 road construction program of this state is to be completed at a minimum cost either a large number of local deposits must be developed or a considerable reduction in freight rates must be obtained. During 1919-1921 the Illinois State Geological Survey, under the direction of F. W. DeWolf, chief of the survey, conducted an extensive survey of the limestone, sand and gravel deposits of the State with reference to the suitability of the materials for use in the construction of concrete highways. (See "Proceedings;" Illinois Society of Engineers, 1920).

The limestone deposits of any great commercial importance are in the northern, northeastern, southern and western parts of the State. Bluff areas occur along the Mississippi River to a considerable extent, but only in a few places have these been developed. The rock in the south-central part of southern Illinois is so deeply buried under the glacial drift that the bed rock is exposed rarely, and then only along the creeks. Outcrops that do occur are found to consist mainly of the shales, sandstone and thin limestones. As the limestone seldom reaches a thickness much over six feet, usually less, no great quantity of rock is available. However, since the large commercial plants are in many cases more than 100 miles away, such deposits may be a profitable source of material for small jobs such as culverts, road repairs and occasional small stretches of new roads.

Judging from test analyses probably the best limestone for roads is obtained in Will county. Although the average coefficient of wear of rock obtained along the river is slightly above the specified hardness, rigid inspection is necessary to exclude the soft stone prevalent in these deposits.

In the northwestern part of the State enormous quantities of material are available, but the cost of removing the overburden is much greater than at other deposits and the needs have not forced development. There are a number of localities where small areas of rock occur with only a thin covering of drift. Many of these localities are within reach of railroads and may serve as sites for shipping quarries should there be sufficient demand for this material. Numerous local deposits which are distant from the railroads may be used as a source of materials for small stretches of road.

From the accompanying table it is to be noted that the plants of Cook County alone produce about half the total daily output of crushed stone, while the plants in Kankakee and Will counties produce approximately one-fourth of the remainder. It may be assumed that at least 75% of the output of a crushing plant can be utilized in concrete road construction. The only product which cannot be used is the dust or material passing the ¼-inch screen.

Great sources of sand and gravel located in the northeastern part of the State and known as the late Wisconsin moraines, run from large boulders down to medium fine sand. The plants in this district produce more coarse gravel than all the other plants in the State. Considerable crushing is necessary and the question of sizing is merely a matter of demand requirements. The ratio of fine to coarse aggregates, divided on the 1/4-in. screen is approximately 50 per cent, although some plants produce a much greater percentage of coarse material.

Immediately west of these deposits and extending into southern Wisconsin are found materials of a different character known as the Iowa glaciation. The material for the most part ranges from 2 in. pebbles down to fine sand with a comparatively small amount of oversize. Approximately 40 per cent of the material is retained on the 1/4 in. screen and 60 to 70 per cent of that will pass a 1-in. standard laboratory screen. Along the east bank of the Mississippi and the west bank of the Illinois rivers occur the deep loess areas. the gradation of materials ranging from 2-in. pebbles down to fine sand with 40 to 50 per cent above the 1/4 in. and with 70 to 85 per cent of the coarse pebbles that will pass a 1-in. screen.

In the central part of the State are found the early Wisconsin moraines and the Illinois moraines. The gradation ranges from 1 3/4-in. down to sand with not to exceed 30 to 35 per cent above the 1/4-in. and very little above the 1 1/2 in. screen. Probably 90 per cent of this material will pass a 1-in. screen. Along the west bank of the Wabash River the deep loess areas again occur, with about the same type of material as is found along the Mississippi and Illinois rivers. Along the east bank of the Wabash River there is an abundance of material ranging from large boulders down to sand.

The material will run from 50 to 60 per cent above the 1/4 in. of which 50 to 60 per cent will pass a 1-in. screen.

Sand and gravel are pumped in large quantities from beds at various points in the Mississippi river. North of Rock Island coarse material is obtained in appreciable quantites, but materials from south of there consist of a greater percentage of sand, and the small amount of gravel that is reclaimed is too fine for use except in small culvert work. Large quantities of sand have been secured from this source for road construction, but the amount of gravel produced is very low.

Materials appear to decrease in coarseness from pits in the northern part of the State. The southern part is void of any gravel of appreciable size. Gravel from along the Wabash River has been used extensively but the greater percentage is too fine; however, resizing of the material has produced appreciable quantities for road construction.

The best grade of material and the most important deposits are in the northeastern part of the State. This material being especially adapted to road building due to its hardness and gradation. There is a tendency for the sand and gravel in Cook County to be a trifle soft. In several instances it was necessary for the Bureau of Tests to prohibit the use of sand from deposits in this county due to the high percentage of wear obtained on the material. The two greatest evils to combat in the development of a gravel pit are clay content and gradation. The accompanying table lists the daily capacity of gravel and stone commercial plants in the several counties.

County	*Gravel Tons*	*Limestone Tons*	*County*	*Gravel Tons*	*Limestone Tons*
McHenry	12,550	-----	Massac	900	-----
Kane	9,400	-----	Kendall	750	-----
Will	8,500	6,000	Gallatin	600	-----
Alexander	6,500	-----	Henderson	600	-----
Winnebago	5,600	-----	Lawrence	600	-----
Tazewell	4,400	-----	Putnam	600	-----
Vermilion	----	3,000	White	600	-----
Madison	3,900	-----	Wabash	500	-----
Peoria	2,650	-----	Johnson	----	500
St. Clair	2,600	2,400	Union	----	500
DuPage	2,500	2,000	Mercer	250	----
Logan	2,500	-----	Monroe	----	225
Rock Island	2,350	-----	Ford	200	----
Cook	1,750	23,450	Woodford	100	----
Lake	1,700	-----	Kankakee	----	5,100
Ogle	1,700	-----	Adams	----	185
LaSalle	1,250	-----	Clark	----	120
Crawford	1,000	-----	Jersey	----	110
Pike	1,000	-----	Henderson	----	100
Pulaski	1,000	-----	Greene	----	100
Randolph	1,000	-----	Boone	----	100
Bureau	900	-----			
			TOTAL	80,450	45,040

It is to be noted that plants in McHenry and Will counties produce approximately 33 per cent of the total output of sand and gravel. Approximately 43 per cent of the total daily outputs of the plants is gravel retained on the ¼-in. screen. Plants in the northern part of the State produce approximately 60 per cent gravel to 40 per cent of sand. The sand-gravel ratio increases farther south until the plants in central Illinois produce practically all sand.

Enormous quantities of sand, gravel and crushed stone have been shipped from Wisconsin, Iowa, Indiana and Missouri, the Indiana shipments being from pits along the Wabash River, a short distance from the State line.

In summarizing the materials situation in Illinois, it is quite evident that enormous quantities are still available in the State. Sand resources are unlimited and fine aggregates for concrete road construction are available at a fair rate at practically all points. The greatest drawback in road construction is the inaccessibility of sufficient quantities of coarse aggregate. Eventually it will be necessary to move the coarse aggregates to points where materials are not available in quantities. Unless freight rates are equalized the cost of construction will vary considerably.

Small quantities of coarse aggregate are available at various points, but contractors require great amounts for a day's run and it is necessary to secure materials from the large plants in order to supply their needs. Material has been shipped over 200 miles in order to enable the contractor to carry on the construction work with speed.

Some materials which are present in large quantities are unavailable for highway construction due to failure to pass the State specifications. This has led the Bureau of Tests to make investigations which will prove whether or not there is a possibility of utilizing these deposits. The great amount of soft stone which fails to pass the abrasion test has prompted an experiment to show if this material has any decreasing effect on the transverse strength of concrete. Illinois pavements have been designed as slabs with the transverse strength as the deciding point. Assuming a corner as the weakest point in a pavement, a load applied at this point is considered to cause a tensile stress in the upper fibres of the slab. Should soft stone lessen the transverse strength of the slab its presence would be prohibited. If no depreciation in strength results, the use of materials too soft to pass our present specifications would make possible a huge increase in available materials. The tests are being conducted on a large scale.

But the experiment which will do the most to permit the use of aggregates now prohibited is the investigation in gradation of materials, to determine if satisfactory transverse strength can be obtained in concrete which contains smaller aggregate. Our present

specifications call for the use of aggregate 100% of which will pass the 2½-in. screen, 95% passing the 2-in., 30% to 75% passing the 1-in., and not over 5% passing the ¼-in. screen. The tests now being conducted have percentages that vary considerably from these specifications.

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The presence of novaculite in large quantities in the southern part of Illinois, where good gravel and limestone are not to be found, has led the Bureau of Tests to conduct experiments to determine whether the novaculite could replace the specified aggregates. Novaculite is a hard cherty substance containing many cleavage planes and a considerable amount of fine clay which appears to be hard to remove even with washing. The 28-day tests have been completed with remarkably good results, showing very little difference in strength between specimens made with novaculite and with limestone. Specimens for transverse and compressive strength tests were made up in three distinct sets. The first set contained quartz sand as fine aggregate and novaculite as coarse aggregate. The third set contained 40% quartz sand and 60% fine novaculite as fine aggregate and novaculite as coarse aggregate. The latter set was made to determine if it would be possible to use novaculite as fine aggregate as well as for coarse aggregate. The 28-day tests show that this would be possible. However, more faith will be placed in the 60 and 90-day tests.

A great share of the time of the Bureau Tests is taken up with routine testing activities which embrace the inspection and testing of practically all materials used in road work in the state. Inspection is maintained at all sand and gravel pits, stone quarries and cement plants furnishing materials for Illinois highways. This system of inspection has meant a great saving to the materials men, the contractor and the state in many ways, especially by the elimination of rejections at construction sites.

The recent installation of district testing engineers who work in harmony with district construction engineers has proved satisfactory. These testing engineers take care of all troubles in their districts, supervise the activities of the inspectors under their charge and create in general a better feeling between the materials men, the contractor and the state. Plant inspection of stone consists mainly of gradation tests. Stone of which the quality is doubtful is tested in the laboratory, the main tests being for hardness, toughness and abrasive qualities. Heretofore specimens were placed in the cylinders of the Deval abrasion machine and after a certain length of time were removed and weighed for loss due to abrasion.

The powdered or small pieces remained in the cylinders throughout the tests. Believing that this material has the tendency to prevent maximum abrasion the Bureau of Tests had slots made in the cylinders in order to allow the fine dust to pass out and thus prevent any cushioning effect. This test shows more uniform results and will probably be adopted as standard.

Sand inspection includes mechanical analyses for gradation together with a visual inspection for the presence of soft materials. In the laboratory the gradation test is made with tests for organic matter, strength, and amount of silt. In the strength test, briquettes are made up and compared with the strength of briquettes made with standard sand. Fully 100% in strength must be obtained with the sample sand specimens as compared with the standard specimens. The usual method of adding 3% of sodium hydroxide to the sand samples and observing the resultant color is used in determining the presence of organic matter. The Bureau is at present endeavoring to find a test which will show the percentage of soft material in sand.

Through the method of inspection at plants, Illinois was able during the past year, to satisfactorily inspect over 1,000,000 cu. yd. of concrete aggregates, over 1,250,000 barrels of cement and over 5,000,000 lb. of reinforcing steel. This amount of material went into the construction of approximately 425 miles of concrete road. With the program of construction for 1922 it has been estimated that approximately three times as much material as was inspected in 1921 must be taken care of this year.

RESURFACING OLD PAVEMENTS

BY HARLAN H. EDWARDS

The problem of resurfacing pavements is one which is troubling many cities today. It is one which has become more acute because of the lack of adequate maintenance during the war period and, consequently, is now taxing the city treasuries severely. This condition is especially true in the cities of the mid-west, many of which have been in active existence but a few score years. In most of these cities, street paving has been in use but thirty or forty years, so that many of their principal streets, which were laid in those early days, are now demanding new pavements or new and smooth wearing surfaces.

The term "resurfacing" must include the replacing of the old top course with a new one of similar or suitable character. Brick pavements were the chief ones laid in the earlier days and are, consequently, the principal pavements needing attention now, due mainly to the disastrous effect of heavy trucks on the old foundations, and to the lax methods in the replacement of pavements over old sewer trenches.

As a rule, the foundations for these old brick pavements were either of compacted crushed stone or gravel, or were one course of brick laid flat on a few inches of sand or gravel and rolled thoroughly, since concrete was little known and less used for pavement bases at that time. Years of increasingly heavy traffic have thoroughly compacted these old bases. At the same time, years of installation and repair of sewer, water and gas pipes have tended to destroy what original continuity of surface there was, until now little more than a series of ruts and bumps remain of what at first was a solid, smooth pavement. A few of the old pavements have escape the destructive action of the excavator and remain as originally, smooth and durable, samples of what the other pavements might still have been, had they not been cut up and "replaced" in the old haphazard way.

The recent experience of one of our small Illinois cities in resurfacing pavements may be taken as characteristic of our present methods of dealing with this problem. Like many other cities, the serviceability of a number of the older streets was reduced to old, bumpy, uneven pavements. The construction of sewers, etc., had ruined some of the streets, while heavy traffic had ground out the wearing surfaces of others. All of them called for immediate attention. The methods of handling these various jobs are worthy of note.

The first one was in the wholesale district where the pavement had been nearly destroyed by the installation of a large and deep storm sewer. The original pavement was of 2-course brick construction, the top course of which after many years of good service had become badly worn and was loosening in spots. This was removed completely, and the lower course of brick cleaned off. A minimum of three inches of fine gravel concrete was laid upon this, leveling up the pavement as well as giving it added strength. A ¾-in. sand cushion was then placed, upon which the 4-in. straight wire-cut brick pavement was laid, and the joints filled with asphalt. This provided a very satisfactorw new wearing surface at $2.98 per square yard, exclusive of excavation, a cost materially less than that of a new pavement. This was done in 1919.

Another old brick pavement, which had been subjected to extremely heavy teaming from brickyards and coal mines, was resurfaced with 3-in. vertical-fiber brick, asphalt filler, in a somewhat similar manner. In this case the foundation consisted of a 5-in. natural cement concrete base, laid upon a fairly well drained subgrade. The combined action of steel tired wagon traffic and the expansive action of heat and cold upon a poorly grouted brick surface practically ruined the top course. The old brick and sand cushion were removed, the old base cleaned off and a new cement-sand bed placed upon it having a minimum thickness of 2 in., and mixed one part portland cement to five parts sand. The 3-in. brick

were at once laid flat upon this bed, rolled and wet down. After four or five days, when the brick had dried out, the asphalt filler was applied and the street opened to traffic one block at a time. This provided a pavement stronger, better, and smoother than the original. The cost was $2.80 per square yard in 1921, including the excavation and removal of all top brick and sand cushion.

Resurfacing other old brick streets by placing a 3-in. sheet asphalt pavement upon the old surface was used on some of the streets in the main retail business section, and upon several of the principal residence streets. The character of these old pavements varied from 2-course brick on sand to a 1-course brick on stone or gravel. All were about thirty years old. In handling this kind of work, new gutter-grades were established about 3 in. above the old pavement grade, and were marked by a chisel upon the curb at intervals of about 2 ft. A chalk-line was then snapped upon the side of the curb, using these marks as guides, giving the new gutter-level very plainly for the guidance of the asphalt layers.

Before applying the asphalt, the old brick street was thoroughly swept; all dirt was removed from the joints to a depth of about ½ in. and a sprinkle coat of asphaltic cement applied. Upon this the 1-in. binder course of asphaltic cement, sand and gravel was laid and rolled, followed by the 2-in. wearing course, composed of fine sand, stone dust and asphalt, all rolled thoroughly to a smooth, even surface, free from waved or uneven spots. This provided a pavement surface which is smooth and durable at $2.47 per square yard in 1921, not including any binder used in excess of a thickness of 1 in. after rolling. For all ''extra'' binder used to fill holes or depressions, an additional price of $12 per ton was paid.

With this method of resurfacing, however, the price paid far the wearing surface is not the total cost. On account of the inevitable reduction in curb height, additional storm water sewers must be provided, with inlets placed at frequent intervals. Pavements at intersecting streets and alleys must be relaid to meet the new grades 3 in. above the old, and at intersections where water drains upon the resurfaced street, new inlets must be provided, or the entire turnout relaid to a new and lower grade if that is possible. In estimating the cost of such projects, all things entering into the final cost must be cinsidered.

In many cases the type of resurfacing material economically suitable will depend upon the topographical location of the street, the character of its traffic, the character and stability of the old pavement, and the original curb height. On one of the streets resurfaced with asphalt recently, the cost of the asphalt work was $42,000, or $2.47 per square yard, while the cost of the incidental work exclusive of non-esssentials was $20,000, or an extra cost of about $1.20 per square yard of pavement laid. A new brick surface could have been laid probably at a less cost on this street and the original grade maintained, while on the other hand, an asphalt

resurfacing job might have been cheaper on a street having little or no surface drainage entering upon it from cross streets. Where street car tracks exist on a street which is to be resurfaced, it is highly desirable to maintain the original grade, for any change carries with it an enormous expense compared to benefits derived, for raising the entire track structure.

Replacement of openings made in bituminous streets in small cities that are unable to support a permanent asphalt mixing plant is a problem to the untrained street repairmen. Any non-bituminous pavement, on the other hand, requires little skill in its repair or replacement, and such repairs should be accomplished at a moderate cost. Where permanent asphalt mixing plants exist, however, or in cities where the yardage of bituminous pavements is sufficiently great to warrant the giving of special attention to their replacement, the cost of such work should not prove excessive.

It is finally evident, then, that there is a place for every type of durable pavement, that also some pavements cost more for certain jobs than others; and that for economy's sake we should be guided in our selection of type of pavement by the conditions at hand, and no by personal preferences.

ILLINOIS RIVER FLOOD: 1922

The flood of April, 1922, in the Illinois River reached the highest stages ever known, although the flow was relatively small, this condition being due to restriction of the high-water channel by the levees which protect lowland drainage districts. The flood was the result of long-continued heavy rains, especially on the Sangamon River watershed. The crest heights were about 24 ft. at Peru, 25 ft. at Peoria, 22½ ft. at Havana, and 25 ft. at Beardstown. These were 5 ft. higher than the previous high record at Beardstown, and 2¾ ft. higher than that at Havana. Levees broke at Peoria and Beardstown and resulted in the flooding of large areas of land. The flooded drainage districts were as follows:

	Districts	*Acres*	*Damage*
1.	La Marsh (Pekin)	3,500	$250,000
2.	Liverpool (above Liverpool)	5,000	25,000
3.	Thompson Lake (opposite Havana)	7,000	40,000
4.	Quiver Lake (above Havana)	5,000	30,000
5.	Kelly Lake (above Browning)	3,000	110,000
6.	Coal Creek (opposite Beardstown)	7,000	500,000
7.	Lost Creek (above Beardstown)	2,000	75,000
	Beardstown (city)	800	400,000
	Crane Creek and district	4,000	120,000
8.	Kerr and Crane (behind Legrange Lake)	2,500	25,000
9.	Meredosia Bay (above Meredosia)	5,500	250,000
10.	Naples (and vicinity)	500	100,000
11.	Scott County (below Naples)	12,000	500,000
	Hartwell	3,000	100,000
12.	Fairbanks (opposite Kampsville)	10,000	350,000
	Total	72,800	$2,875,000

HAROLD E. BABBITT
President
ILLINOIS SOCIETY OF ENGINEERS
1923
Assistant Professor of Municipal and Sanitary Engineering
University of Illinois

LIST OF ADVERTISERS

ENGINEERING CHARGE FOR SPECIAL ASSESSMENT WORK

An important activity of the Society in 1922 was in relation to the charges for engineering in connection with special assessment work. In the special assessment suit of the City of Carlinville *v.* Anderson the Supreme Court of Illinois, in 1922, rendered a decision to the effect that engineering and inspection during the construction of improvements are not a part of the cost of the work. This operates to the disadvantage of many improvements in the smaller municipalities, in that they have no corporate fund out of which to pay these expenses.

It was considered by some of the officers and members of the Illinois Society of Engineers that by action of counsel a rehearing of the case might be obtained and might result in a modification of the above opinion. A committee was appointed by President Randolph, consisting of G. C. D. Lenth (chairman), C. E. DeLeuw, W. S. Shields and S. A. Greeley. This committee engaged Geo. A. Mason as attorney to represent the Society in a petition for a rehearing. This was denied, but the original opinion was modified slightly, so that some good was accomplished. The substance of the report of the attorney is as follows:

"The original opinion held that inspection of work during its progress was a personal duty imposed upon the Board of Local Improvements and that the cost thereof should be paid for out of the six per cent provided for in Section 94 of the Local Improvement Act. In our argument for a rehearing or a modified opinion, it was pointed out that there is nothing in Section 94 covering inspection and that the six per cent item, therefore, could not have been intended by the legislature to cover the cost of inspection and engineering during the construction of the work. The modified opinion of Mr. Justice Cartwright answers that suggestion by holding that Section 94 does provide among other things for the letting and executing of contracts and that the execution of the contract means its performance. In that way the modified opinion brings the inspection of the work under the head of "executing contracts" and within the six

per cent item provided for in that section. As nothing more can be acomplished in this particular proceeding, the next step will be to ask the legislature to amend the statute so as in terms to permit the inclusion of a separate item in the estimate of cost to cover the cost of inspection and engineering during the progress of the work. In the meantime, it will be optional with the municipality to go back to the old practice of including the engineering item in the unit prices contained in the estimate of cost or to leave the expense of inspection and engineering during progress of work entirely out of the estimate and assessment."

At the Peoria meeting, 1923, this subject was discussed and it was voted to appoint a committee to consider plans to carry into effect such measures as will be of advantage to the engineering profession in Illinois. The main point is the amendment of the Local Improvement Law so as to include the cost of engineering as an item in the estimate of cost in the ordinance for an improvement. This legislative committee held a meeting at Peoria and it was suggested that the committee should prepare the necessary amendments to Sections 88, 89 and 94 of this law and should sponsor them before the State legislature.

RESOLUTIONS ADOPTED AT THE 1923 MEETING

1. IMPROVED PLUMBING CODES.—There is need of improvement and simplification of city plumbing codes and practices, and the Illinois Society of Engineers therefore commends and urges the continuance of the efforts of the Illinois State Department of Public Health, the engineering experiment station of the University of Illinois, and the plumbing sub-committee of the building code committee of the U. S. Department of Commerce, which are accomplishing much in this direction by their studies, experiments and conferences.

2. DEVELOPMENT OF UNDERGROUND WATER SUPPLIES.—The underground waters of the State of Illinois constitute a valuable resource for municipal, industrial and private water supplies, and a more complete knowledge of the water-bearing strata, especially at greater depths, would aid materially in the economy and extent of the exploitation of these great reservoirs. Since the State Geological Survey and the State Water Survey have compiled data on water well borings in various parts of the State which have been a considerable aid to engineers in providing water supplies and designing water works, the Illinois Society of Engineers commends the joint work of these departments and urges its enlargement through the aid of more adequate appropriations.

3. CONTROL OF SEWAGE TREATMENT WORKS.—Investigation indicates a general tendency to neglect of the operation of sewage treatment plants, and the State Department of Public Health has made inspections of such plants, examined plans for proposed plants, assembled data on sewage disposal practice of considerable value to engineers, urged the employment of competent engineers to supervise such plants, and

has exercised the police powers of the Department in order that the cleanliness and purity of the waterways may be maintained, that the art of sewage disposal may be improved, and that water supplies, bathing beaches, fish life, and public health and welfare may be conserved. The Illinois Society of Engineers therefore commends the Department for its work along these lines and favors their continuation with the aid of more adequate appropriations.

4. TAX FOR PUBLIC BENEFITS.—A law passed by the last State legislature (House Bill No. 544) provides relief for obtaining public improvements on the special assessment plan by authorizing the levy of a special tax to cover public benefits, but limits this relief to municipalities having population in excess of 2,500. The Illinois Society of Engineers recommends that this law be amended to remove this limitation and to make it apply to all incorporated municipalities. (This resolution was referred to the Society's committee on legislation.)

5. MECHANICAL, ELECTRICAL AND MINING ENGINEERS.—It has been suggested that the scope of the Society's activities should be enlarged by interesting an increased membership among mechanical, electrical and mining engineers. For this purpose a committee of three members should be appointed by the president to investigate and to report to the Executive Board the feasibility of forming a section devoted to these lines of engineering, with the understanding that the committee may take action, subject to the advice and consent of the Executive Board.

PROCEEDINGS OF ANNUAL MEETING, 1923

The Society's thirty-eighth annual meeting was held January 23 to 25 at the Jefferson Hotel, Peoria, Ill., and was highly successful both as to technical and social affairs. The president, Robert Isham Randolph, was in charge of the regular sessions, and the entertainments were arranged by Harris J. Harman as chairman of the local committee. There was a total registration of 73, including 48 members, while 14 new members were elected.

JANUARY 23.—The first session was opened at 2 p. m. by the president, Robert Isham Randolph. Two papers were presented: "Mechanism of the Activated Sludge Process from the Chemist's Point of View," by Dr. A. M. Buswell, chief of the State Water Survey; "Status of Sewage Disposal in Illinois," by H. F. Ferguson, chief sanitary engineer, State Board of Health, and Paul Hansen, consulting engineer. A report of the committee on Plumbing Code was presented by H. E. Babbitt. The president appointed committees as follows: On nominations—J. J. Woltman, C. M. Roos, Ray Crozier; on resolutions—P. E. Green, W. D. Gerber, Paul Hansen. At the evening session the following papers were presented: "Predicting the Results of Deep Well Borings," W. T. McClenahan; "Regulation of Cost of Essential Commodities," C. M. Roos; "Orders and Opinions of the Illinois Commerce Commission," W. B. Bushnell, superintendent of the Champaign & Urbana Water Co.; "Water Supplies from Gravel Deposits in the Illinois River Valley," Geo. C. Habermeyer, engineer of State Water Survey; "Geological History of the Illinois River Valley in Relation to Its Water Supplies," M. M. Leighton, geologist, State Geological Survey.

JANUARY 24.—Two papers on "Open or Closed Specifications for Asphalt Paving" were presented by C. R. Andrews, city engineer of Decatur, and L. D. Jeffries, city engineer of Peoria. Other papers were as follows: "The Automobile Industry in Relation to Traffic Problems," by Prof. C. M. Hewitt, of Bradley Polytechnic Institute; "Lighting Streets and Highways," by Prof. A. R. Knight, University of Illinois; "Results of Tests on the Bates Experimental Road," Clifford Older, State highway engineer; "Curing Concrete Roads with Calcium Chloride," H. F. Clemmer, engineer of tests, State Highway Division. Excursions to the plant of the Holt Mfg. Co. and the Keystone Steel & Wire Co. occupied the afternoon.

At the evening session, moving pictures of work of the Sanitary District of Chicago were exhibited by courtesy of E. J. Kelly, chief engineer of the District. An address on "Effect of Channel Straightening on Flood Heights" was given by M. G. Barnes, chief engineer of the State Highway Division. A business session was then held, at which the committee on nominations presented two tickets. The ballot votes were as follows: For president, H. E. Babbitt (27) and E. A. Rossiter (2); for vice prseident, E. E. R. Tratman (26) and Edmund Hall (3); for trustees, H. J. Harman (18) and Paul E. Green (21), A. C. Stanfield (10) and C. E. DeLeuw (9). The election of Messrs. Babbitt, Tratman, Harman and Green was announced. For the 1924 meeting, Urbana and Springfield were put in nomination and received 21 and 8 votes, the election resulting in favor of Urbana and the University of Illinois. At the close of the meeting there was a buffet lunch and social gathering.

JANUARY 25.—After a short discussion on land survey work, a paper on "City Planning and Zoning" was read by Jacob L. Crane, Jr., Chicago. This was followed by a discussion on the appointment of a committee to consider an amendment to the special assessment law to include the cost of engineering as a separate item in the estimate of cost of improvement in the ordinance. This was carried, including an appropriation of $200 for the work of the committee, and the president appointed the committee as follows: G. C. D. Lerth, J. J. Woltmann, Geo. Reiter, P. E. Green, W. D. P. Warren. A paper on "Psychology Tests and Their Uses," by Prof. A. F. Siepert, Bradley Polytechnic Institute, Peoria, closed the session.

At the afternoon session, papers were presented as follows: "Swamp Drainage for Eradicating Mosquitoes in Illinois," H. F. Ferguson, chief engineer of State Board of Health, and A. F. Dappert, assistant engineer; "Land Drainage and Development in Minnesota," with moving pictures, J. W. Dappert, Taylorville; and "Drainage Conditions in the Southern Alluvial Valley of the Mississippi," Jacob A. Harman, Memphis, Tenn. A report on the Illinois drainage laws was presented by L. K. Sherman and was adopted. The annual dinner was held at the hotel in the evening.

REPORT OF THE SECRETARY

During the year the secretary has supplied inquirers with lists of dredging contractors, drainage engineers, and engineers for the design of water works and sewerage plants. A letter was sent to U. S. Senator Smoot urging the passage of the bill for the relief of the U. S. Patent Office and pointing out the important relation of inventors to the welfare and development of the country. Thanks for the resolutions passed by the Society at its annual meeting of 1922 were received from President Harding, Secretary Hoover, Dr. Geo.

Otis Smith of the U. S. Geological Survey, Gov. Small and Mr. Frank Sheets, State Superintendent of Highways.

Many members of the Society attended the National Drainage Congress, held at Kansas City, in October, and several engineers were elected vice presidents. It is of special interest to note that Mr. Jacob A. Harman, of Peoria, a past president and long-time member of the Society, was elected president of the National Drainage Congress for 1922–23. In view of the revision of old drainage laws in some states and the desirability of uniformity in State laws relating to the organization and operation of drainage districts, a draft of a law suitable for adoption by any State has been prepared by Mr. Harman. A long article by him giving a careful discussion of the advantages of such uniform legislation, was printed in "Engineering News-Record" of April 27, 1922, and that paper has also published the text of the proposed law in pamphlet form.

At the Southern Commercial Congress held at Chicago in November, our then president, Mr. Robert Isham Randolph (representing this Society), gave an address on "The Business and Function of the Consulting Engineer," in which he showed the important relation of the engineer to commercial development and public welfare. This is the sort of publicity that helps the engineer by giving the layman a better idea of engineers and their work.

Owing to the greatly increased cost of printing, some of the Societies with which we have been accustomed to exchange Proceedings have so reduced their editions that they could supply us with only a few copies of their Proceedings. For this reason notices were sent to members explaining the situation and asking them to state if they wished any exchanges and if so for what Societies. The replies indicate that comparatively few members are interested in the exchanges. Our own "Proceedings" had to be reduced somewhat to keep expenses within our limits, but they were supplemented by four Bulletins issued during the year to keep members informed of the activities. It was decided not to continue the competition for technical papers written by our members, as so few papers were submitted in the competitions of the previous years.

In the accompanying financial statement is given a summary of the Society's business for the year. Since the Society is an incorporated body and is registered in Cook county, a certificate of election of officers was filed with the county recorder of Cook county, as required by law.

E. E. R. TRATMAN, *Secretary and Treasurer.*

FINANCIAL STATEMENT, DECEMBER 31, 1922

Bank Balance, December 31, 1921		$ 116.17
Receipts, 1922		
Annual dues	$858.00	
Entrance fees	69.00	
Sale of "Proceedings"	2.50	
Advertisements	590.00	
Fund for Special Assessment inquiry	327.50	
Interest on Liberty Bonds	40.39	
Reprints	15.00	
Total for 1922		1,902.39
Total		$2,018.56

Expenditures, 1922

Printing and distributing "Proceedings"	$ 629.26
Printing and stationery	117.10
Bulletins	46.02
Stamps and telegrams	53.60
Express and freight	9.35
Typewriting	12.80
Convention, 1922 (2nd poster, local comm.)	68.00
Programs, 1922	48.00
Badges, 1922	17.15
Donation to local committee (Decatur)	75.00
Certificate of election of officers	.55
Secretary	250.00
Subscription: National Drainage Congress	15.00
Subscription: "Drainage Magazine"	2.00
Prizes for papers (two at $25)	50.00
Executive committee, traveling expenses	26.00
Fee to attorney on Special Assessment inquiry	350.00
Miscellaneous	11.41
Total expenditures	$1,781.24
Total receipts	2,018.56
Bank balance, December 21, 1922	237.32

Savings account (reserve)	$300.13
Liberty bonds	400.00
Due from members (unpaid dues)	204.00

Bills payable, $60.70.

MEETINGS OF EXECUTIVE BOARD

Meeting of 1922 Board: Jan. 24.—The work of the officers during the past year was approved, and the report of the treasurer was read and approved.

Meeting of 1923 Board: Jan. 25.—It was decided that city planning should be included in the work of the surveying section, the name being changed to the Surveying and City Planning Section. It was voted to appoint E. E. R. Tratman as secretary and treasurer for 1923.

CONSTITUTION AND BY-LAWS (Revised 1918 and 1921)

ARTICLE I—NAME.—This Association shall be called the Illinois Society of Engineers.

ARTICLE II—OBJECTS.—The objects of this Society are the encouragement of professional improvement and of goodfellowship among its members by meetings for the presentation and discussion of papers on scientific and other kindred topics pertaining to engineering, and the discussion of such other subjects as may be of interest to its members; the publication of such parts of its proceedings as may be deemed expedient; and the collection and preservation of books, maps, drawings, and other articles of value to the profession represented in its membership.

ARTICLE III—MEMBERSHIP.—Section 1.—The membership of the Society shall consist of Members, Honorary Members and Affiliated Members. Members shall constitute the corporate membership of the Society and shall have the exclusive right to vote and hold office in the Society, but members of all grades shall have the right to vote and hold office in the various sections.

Section 2.—A Member shall be a person qualified either by education or experience to design, execute or maintain works of an engineering or public character.

Section 3.—An Honorary Member shall be a person of acknowledged eminence in some branch of engineering or science related thereto, or who has rendered some special service to the engineering profession or this Society. He may be elected to such membership by unanimous ballot of all the members, not less than twenty in number, present at any regular meeting of the Society.

Section 4.—An Affiliated Member shall be a person who may not be qualified for membership under Section 2, but who is interested in matters relating to engineering work or who is interested in the manufacture and sale of supplies and materials used in engineering construction or who is a student in residence in a college of engineering of recognized standing.

ARTICLE IV—ADMISSIONS.—Section 1.—Each candidate for membership shall make application in writing to the Secretary on a printed form provided therefor by said Secretary. Such application shall give the name, age, place of birth, residence, present occupation and the nature and extent of professional services of the applicant and must give personal reference to three engineers, preferably members of the Society. Each application for membership shall be accompanied by the admission fee, which will be refunded if the applicant is not elected.

Section 2.—Application for transfer from Affiliated Member to Member shall be made in writing to the Secretary. Such application shall state fully the professional service upon which the request is based. No admission fee shall be required for such change in grade of membership.

Section 3.—Whenever any application for membership or transfer in grade is received by the Secretary a copy thereof shall be submitted to the members of the Executive Board within one month from date of receipt. It shall be the duty of each member of the Executive Board within ten days from the receipt of the copy of any application, to send his vote upon the election ti the Secretary. A majority of votes in the affirmative shall elect the applicant to membership. The Secretary shall include in his report to the Society the names and post office addresses of all persons elected.

Section 4.—A member of any grade may resign his membership by a written communication to the Secretary, who shall present the same to the Executive Board, when, if all dues have been paid, the resignation may be accepted.

ARTICLE V—DUES.—Section 2.—The admission fees and annual dues for the various grades of membership in the Society shall be as follows:

	Entrance Fee	Annual Dues First Year	Annual Dues Succeeding Years
Honorary Member	none	none	none
Member	$3.00	$2.00	$4.00
Affiliated Member	$2.00	none	$2.00

Section 2.—The annual dues are due and payable in advance.

Section 3.—Members whose dues are in arrears for one year shall receive the annual "Proceedings" of the Society but shall not be entitled to the "exchange proceedings" provided by arrangement with other societies.

Section 4.—Members whose dues are in arrears for two years and who offer no explanation for such delay shall be dropped from mem-

bership, provided, however, that the Executive Board shall have authority to remit such back dues and to continue such membership when in their opinion such action is justified by circumstances.

Section 5.—Every person admitted to membership in the Society shall be liable for the payment of all dues until he shall have resigned or have been dismissed by action of the Executive Board.

Section 6.—The fiscal year shall be coincident with the calendar year.

ARTICLE VI—OFFICERS.—Section 1.—The officers of this Society shall be a President, a Vice President, a Secretary-Treasurer and four Trustees.

Section 2.—The officers of the Surveying Section, Drainage Section and Structural Section shall each consist of a chairman, and three trustees, who shall constitute its Executive Committee. The officers of the Sewerage Section and the Road and Pavement Section shall each consist of a chairman, two vice chairmen and four trustees, who shall constitute its Executive Committee.

Section 3.—The officers of any committees shall be appointed by the President.

Section 4.—The management of the Society shall be vested in an Executive Board, consisting of the President, Vice President, Secretary-Treasurer, four trustees, the chairmen of the sections and the two latest Past Presidents.

ARTICLE VII—ELECTION OF OFFICERS.—Section 1.—The officers of the Society shall be corporate members and residents of the State of Illinois. They shall be elected by ballot by the corporate members during the annual meeting; and shall hold office until their successors have been elected, except the Secretary-Treasurer, who shall be elected annually by the Executive Board.

Section 2.—The President and Vice-President shall hold office for one year, and the Trustees for two years, two being elected each year.

Section 3.—The members of the Executive Committee of each Section shall be members of that section. They shall be elected by ballot by the member thereof at the annual meeting of the Society.

Section 4.—A vacancy occurring in any office in the Society may be filled by appointment by the Executive Board. A vacancy occurring in any office in a setion may be filled by appointment by the Executive Committee of that section.

ARTICLE VIII—DUTIES OF OFFICERS AND COMMITTEES.—Section 1.—The President, Vice-President and Secretary-Treasurer shall perform the duties usually pertaining to their several offices. The President shall preside ac Chairman of the Executive Board and the Secretary shall act as Secretary of the Board.

Section 2.—As Secretary, the Secretary-Treasurer shall be custodian of all the property of the Society and shall deliver all such property to his successor. He shall prepare an annual report concerning the affairs of the Society. He shall record the proceedings and discussions of the meetings and shall prepare a copy of them for the Executive Board. He shall be ex-officio librarian of the Society and as such shall collect and preserve all books, pamphlets, papers, and documents belonging to the Society and upon retirement from office he shall deliver all such property to his successor.

Section 3.—As Treasurer, the Secretary-Treasurer shall keep an account of the financial affairs of the Society and shall render a financial report of all receipts and disbursements at the annual meeting.

He shall pay only such orders as are signed and approved by the President.

Section 4.—The Executive Board shall audit the accounts of the Treasurer before each annual meeting and shall render a report thereon to the Society at the annual meeting. The Executive Board shall be vested with the general conduct of the affairs of the Society and shall act on all matters concerning the Society between the annual meetings. It shall approve the execution of all contracts and the expenditures of all moneys.

Section 5.—The officers of the sections and committees shall be responsible for the programs of papers and discussions for their respective sessions, but all such programs shall be submitted to the Executive Board for approval. The Executive Board shall supervise the arrangement of the general programs for the meetings and of all committee and section programs, and shall set apart a certain time for their proper presentation of the latter to the members.

Section 6.—The Executive Board shall have the authority to create new sections or to discontinue any section whenever the Society will be benefited thereby.

ARTICLE IX—SECTIONS AND COMMITTEES.—Section 1.—Following the annual meeting there shall be appointed such committees as the Executive Board may deem advisable and necessary.

Section 2.—It shall be the duty of such committees to collect facts, figures and items of interest in their respective departments, and make a report to the Society at the next annual meeting.

Section 3.—To facilitate the study and discussion of special branches of engineering the following sections are created: 1, Surveying Section; 2, Drainage Section; 3, Structural Section; 4, Sewerage Section; 5, Road and Pavement Section.*

Section 4.—Each section shall have the right to adopt rules for the transaction of its meetings, such rules to be subject to approval by the Executive Board of the Soiety.

Section 5.—No indebtedness shall be incurred by a section without the permission of the Executive Board of the Society.

ARTICLE X—PUBLISHING ANNUAL REPORTS.—The Executive Board shall compile and publish the annual report of the transactions of the Society. It shall include in this report all items of general interest in the proceedings, and such other matters as may seem advisable.

ARTICLE XI—COMPENSATION FOR OFFICERS.—The Society may provide for the compensation of its officers for their services whenever deemed advisable, except that the compensation of the Secretary-Treasurer shall be fixed annually by the Executive Board.

ARTICLE XII—AMENDMENTS.—All propositions for amendments to this Constitution shall be submitted in writing to the Executive Board for its review. The amendment, together with the report of the Board, shall be submitted to the members within 60 days for a letter ballot. An amendment shall be declared adopted if the affirmative votes represent two-thirds of the total number of votes cast, not less than 50 members voting.

ARTICLE XIII—AFFILIATION WITH OTHER SOCIETIES.—Whenever in th opinion of the Executive Board the objects and aims of the Society can be accomplished better and the Society can be of greater service to the engineering profession by becoming affiliated or amalgamated

*NOTE—The structural section was dropped by vote of the Board, Jan. 25, 1923, as it was never organized and did no work.

with another engineering society, or when a proposition for such affiliation or amalgamation shall be presented to the Executive Board signed by not less than twenty active members of the Society, then the Board shall print the reasons for and the details of the proposed plan and shall submit the same to the membership of the Sociey in the form of a letter ballot.

If the proposed plan of affiliation or amalgamation shall receive an affirmative vote of the majority of the active members of the Society then the Board, withou further vote, shall enter into an agreement or contract in accordance with the plan submitted; provided, however, that any plan which may be rejected shall not be presented again before the next annual meeting.

The provision of Article XII on amendments to the Constitution shall not apply to the proposition of affiliation or amalgamation.

BY-LAWS

Section 1.—The annual meetings of this Society shall be in such place as shall be determined by the Society at each previous meeting, and at such time in January as shall be determined by the Executive Board. The Executive Board shall notify each member of the Society at least twenty days before the date of the annual meeting.

Section 2.—Ten members shall constitute a quorum for the transaction of business.

Section 3.—The meetings of this Society shall be governed by "Robert's Rules of Order."

Section 4.—The order of business shall be fixed by the Executive Board.

Section 5.—A record of all donations to the Society, whether in money, books, maps, models, or other articles of value, with names of donors, shall be entered by the Secretary in a book provided for that purpose.

Section 6.—These By-Laws may be amended by a two-thirds vote of the members present at any annual meeting, not less than fifteen members voting.

CITY PLANNING AND ZONING IN ILLINOIS

By JACOB L. CRANE, JR.

Ten years ago the term "city planning" was popularly considered to mean the city beautiful, and the city beautiful to signify window boxes and street trees. This phase of city planning served a good purpose but it was essentially superficial. It has now given way to a new and more fundamental conception of the city as a single complicated machine operating for three main purposes: (1) the promotion of industry and commerce; (2) the provision of adequate facilities for residence; and (3) provision for satisfying the recreational and cultural needs of the population. To this end city planning is now conceived as the science and art of planning the future development of a city in all its physical details to fulfill these three main functions; the planning to

be based in every case on an intensive survey of the resources, physical conditions and possibilities of the community as a working unit.

With this new conception of city planning as a practical utilitarian thing, popular interest in the idea has grown rapidly and the number of cities officially interested in city planning projects has been fast increasing. This increasing popularity of city planning has been accelerated during the past five years by the great interest shown in that phase of city planning called zoning. Zoning was introduced in New York City in 1916. During the next three or four years a few other cities tried it; and on the basis of its complete success in these places, the idea spread very rapidly, so that now zoning is the vanguard in the city planning movement. Within the past three years many cities have taken up zoning as the first step in city planning. The cities in Illinois which have made a start in city planning and zoning include: Chicago, Joliet, Rockford, Elgin, Decatur, East St. Louis, Aurora, Evanston, Springfield, Cicero, and about twenty of the towns around Chicago. This makes a total of 30 cities and towns in Illinois, placing our State second or third in this field in the United States.

The year 1921 saw two vital factors introduced into the city planning and zoning situation in Illinois; these were two enabling acts passed by the legislature: one authorizing cities and villages to zone, and the other authorizing them to prepare city plans. The zoning law provides for the creation of zoning commissions to prepare zoning ordinances for presentation to the city councils for passage. This law is considered one of the best in the country, and although it does not give all of the leeway which might be desired, still it probably takes advantage of as much authority as the legal limitations would permit for zoning in this State. The city planning law provides for commissions to draw up comprehensive city plans. These laws provide that a single commission may act for both functions, but the commission to draw a city plan must include in its membership the mayor and the president of the Board of Local Improvements, who must be designated as ex-officio members of the commission. It is in fact a great advantage to have a single commission for both the zoning and city planning projects, because zoning is really only a branch of comprehensive city planning and it can be done properly only on the basis of the general surveys fundamental to comprehensive planning.

These surveys, sometimes called the "civic survey," include in general four main subjects of investigation: (1) the eco-

nomic and industrial survey; (2) the social and health survey; (3) the financial and legal; and (4) the physical. The engineer is concerned primarily with the first of these, and more particularly with the last, which includes topography, population, transportation, communication, streets, water supply, drainage, building development, recreation, public buildings and many special items.

As soon as the expert begins to study city planning for a given community, he realizes that the planning problems do not end at the corporation limits. In fact they are related to similar problems in the neighboring communities and in the territory between. This consideration has led to a new development in the field of city planning; namely, regional planning.. It is true that the Illinois city planning law provides that cities which adopt an official city plan may impose that plan so far as streets and other open spaces are concerned for a distance of 1½ miles outside of the corporate limits, and this is an extremely important advantage because it permits the city to control the territory which lies outside its present limits and over which the city will be extended as it grows. For the large cities, however, this does not give a large enough territory for controlling future developments, and here regional plannnig is required.

Regional planning involves the same kind of survey and in general much the same type of comprehensive planning for the future as does city planning, but it is applied to an entire region, usually the region surrounding a large city and embracing its metropolitan area. Such regional planning projects have been undertaken in a number of places in Europe, where I had the pleasure of studying them in detail a year ago, and they have also been instituted in several of the large cities in this country, including New York, Boston, Buffalo, Montreal and Los Angeles. And now we are just undertaking a regional planning project for Chicago, which will embrace twelve counties in northeastern Illinois and northwestern Indiana, extending from the Wisconsin line out beyond Elgin, Aurora, Joliet, Kankakee and around to Michigan City. It is proposed to organize a regional planning conference of the public officials, engineers, and interested citizens in this whole region to make possible a regional survey and eventually a regional plan.

Another interesting secondary development of the city planning movement is the garden city and garden suburb. Reacting from the overcrowded conditions of the great cities, a definite movement for decentralization has set in on the part of the people seeking more agreeable working and living con-

ditions in the country surrounding the cities. This has led to two types of suburban towns: the industrial satellite city and the suburban residential village. Within the last few years model communities of both types have been undertaken in Europe, and similar model communities are now proposed at several points in this country. We are now working on a semi-cooperative garden suburb north of Chicago. By model community I do not mean the superficially pretty town, but rather the town designed with the greatest care for efficiency first, and for good living also.

This gives a general outline of the city planning movement at this time. But who are the men to cary out the city planning projects? My answer is, the city engineers. For many years to come specialists in city planning and zoning will be needed to direct the civic surveys and to prepare the first reports on city planning and zoning projects. But this is only the beginning of the work in the individual city. The surveys must be continued, the plans must be reduced to practical possibilities, and the individual projects must be carried out on the ground. This means that much of the city planning itself and virtually all of the realization of city plans will lie in the hands of the city engineers. For the city engineer this offers an intensely interesting field, and moreover the opportunity for making himself an indispensable factor in the development of his community.

So far as I have been able to find out Peoria is one of the few remaining larger cities in Illinois which have done nothing yet with city planning and zoning. Being engaged at present on city planning and zoning in two of the larger towns in Illinois (Rockford and Cicero), I might speak briefly of the possibility for city planning in Peoria. The first thing to undertake is a comprehensive civic survey. This may be made under the direction of a specialist in city planning. It is a mistake to underestimate the importance of these surveys. City plans based on a false sense of security in superficial surveys may be worse than no plans at all. The surveys should cover the items outlined in an earlier paragraph, and when they are completed usually the best project to take up first is zoning. If a city planning commission has been organized, it may also act as a zoning commission, and this is desirable in many ways. Otherwise a separate zoning commission must be organized. In either case, since the whole future of the city depends on their work, the most competent citizens representing various fields of activity in the city should compose the city planning or zoning commission.

Zoning itself is carried out by the following steps, the

following data from the civic survey being collected for the particular purpose of zoning: (1) existing uses of property and heights and areas of buildings are shown on a set of maps; (2) the street and transportation systems must be mapped, time zones prepared, street widenings, openings and extensions laid out according to traffic rules, and future needs and transportation improvements indicated; (3) the public services must be mapped out along with the topography to indicate the possibility for development in the various sections and extensions of the city and also to determine possible limitations on different types of development; (4) supplemental material may be assembled, such as aerial photographs, terminal studies, park and playground development, public building groups and community centers, and other local items.

With as much of this data as is needed in the particular case mapped and tabulated in the form in which it may be used, preliminary zoning districts are drawn, establishing the uses to which property may be put, the areas which buildings may occupy and the height to which they may be built. A zoning ordinance embodying the proposed regulations is drafted; public meetings and meetings with the civic societies are held to discuss the proposals in a general way; the zoning plan is published, and the public hearings are held to secure the views of property owners. At length the zoning commission submits a final report and proposed zoning ordinance and plan to the city council for passage. Such zoning regulations are not iron-bound restrictions which cannot be changed. In fact the zoning ordinances themselves provide the machinery for making changes so that injustice can be corrected and the general plan altered as the city grows.

Following the completion of zoning the other main projects of city planning for a city like Peoria are: (1) a plan for industrial devlopment covering the transportation facilities, power supply, housing, etc.; (2) a plan for the future system of streets and roads which will meet the anticipated requirements for commercial and recreational purposes; (3) a comprehensive program for the development of a park and playground system; (4) a design for a civic center, possibly connected with a river front improvement; (5) regulations to control future subdivisions within and for 1½ miles outside the corporate limits, in accordance with the Illinois law; (6) industrial and residential suburbs; (7) such items as railroad and street car terminals, river and harbor development, architectural control, and planning of the public services such as water supply and drainage. This outline of a city planning program for Peoria will serve to suggest the

fundamental character and the comprehensive method of modern city planning. It is a large subject and involves the most exhaustive surveys and studies as well as constant conferences with interested citizen organizations in order to make the planning adequate and sound. Provided these requirements are fulfilled, city planning, zoning and regional planning offer the means by which we can make our cities efficient places for business and commerce, and agreeable places in which to live.

While the immediate objective of city planning is for economy in carrying out public improvements and in facilitating business, its ultimate objective also includes the development of beautiful cities; not the city patched up with artificial decoration, but the city fundamentally beautiful because of its careful design for its specific uses, and because of the thought and care put into each project and structure as the city grows and develops. Since it is obvious that city engineers must do a large part of the real city planning and practically all of the carrying out of city plans, and since the Illinois Society of Engineers is the great meeting point in this State for city engineers and engineering specialists, it would seem appropriate that the surveying section of the Society be enlarged in scope to include city planning and regional planning. If the engineer appreciates the possibilities in city planning and the opportunity which it offers him, he will take a large part in this fascinating work which is going to be the means of remaking our cities to the mold of our requirements and our desires for the future.

THE NECESSITY OF EXPERT SERVICE IN ZONING

By Wm. Artingstall

I have read with considerable interest Mr. Crane's paper on " City Planning and Zoning in Illinois," and there are a few remarks which might not be out of place for me to make, and which Mr. Crane in his position could not afford to emphasize. In making the following comments on the employment of experts or experts' services in city planning and zoning, the writer disclaims any intention of posing as an expert on the subject but merely expresses a personal opinion based on his experience as a consulting engineer. During a period of over 25 years, he has been in almost constant and intimate association with the many problems confronting the smaller municipalities in various states and fully recognizes the inestimable value of advice and counsel of the spe-

cialist. The various technical questions are no longer being handled in toto by the individual but are submitted to those who by training and experience have acquired special knowledge and ability in their chosen fields. The writer has never hesitated to avail himself of the services af the expert or to suggest their employment to his clients. Universal satisfaction is sufficient endorsement of this policy and emphasizes his personal conviction that a more general recognition of the additional benefit derived by the employment of expert service will not only substantially lower the cost of municipal improvements (and zoning is a municipal improvement), but the public confidence naturally reposed in the expert will materially aid the solution of many problems that would otherwise enlist only the half-hearted support of authorities or the citizens.

The officials of the average American city are generally successful business men sufficiently interested in the civic affairs of their community to devote time and energy toward the improvement and welfare of their city. On those gentlemen and their associates rests the responsibility of administering the municipal affairs, but the amount of time which can be devoted to public improvements is limited by the requirements of their personal affairs. The detail solution or supervision of public works must of necessity be completed by others and the degree of perfection attained depends on the experience and capabilities of him to whom the work is intrusted. The enormous wastes due to poorly designed sewers, water systems and pavements are familiar to most of us, but the economic loss, the depreciated realty values of residential, industrial, and commercial property caused by indiscriminate and improper location is of such magnitude it can hardly be appreciated. Bassett has estimated an economic loss of over one hundred million dollars for Chicago, or about ten per cent of the vaue of all the real estate.

It is not my intention to criticize the authorities. Every city is a problem in itself and it is practically impossible to adopt a workable zoning ordinance of one city to cover the conditions of another. This has been tried at various times in an attempt to save the small cost of the expert, but the resultant legal expense soon placed the balance in the other column, while the patched up ordinance was declared illegal. It must be appreciated that, as aptly stated by Mr. C. B. Ball, "city planning and zoning is a profession, the practice of which requires long study, training and experience." It cannot be relegated to the already overburdened city engineer and is too important to be entrusted to the amateur. To

prove a success, it must have the support of substantially the whole community. It must be presented in a manner easily comprehended by the layman and not left to the necessarily superficial analysis of the individual citizen.

A program that evidences improvement in the character of a neighborhood or welfare of the community wins almost instant approval and spontaneous support. But the suspicion of a lowering of the social standing serves to unite the whole community in an army of opposition. The degree of support or opposition will vary with the individual opinion of the effect on themselves or their immediate associate. The question of financial gain or loss is merely relative to the improvement or degradation of their social status. Being naturally suspicious, the American citizen hesitates to endorse a scheme of which he is ignorant or when he doubts the ability of the sponsors. "Zoning a city," states the Department of Commerce in a late bulletin, "requires expert professional knowledge. But just as the lawyer depends on the layman to secure the facts, so must the professional expert call upon the citizens for much accurate information upon which any good zoning regulations are based." The citizen acquires a better understanding of the subect while working with the expert and appreciates the able development of the program. A general pride and satisfaction is expressed by the approval of a plan when completed with co-operation between the public and the expert, and presented with a confidence gained by experience and stamped with approval by an authority on the subject

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ASPHALT RESURFACING IN PEORIA, ILL.

By C. D. Jeffries

Asphalt resurfacing over wornout brick pavements was first tried in this city in 1902 on Hamilton St., from Adams to Jefferson, a distance of one block. The old pavement was a two-course brick surface upon a gravel foundation. A half-inch binder course was laid after filling up all depressions in the surface with the same mixture and the wearing surface was one-half inch thick. This street was subjected to a heavy traffic and gave good service for almost 10 years when the surface became badly cracked and began to disintegrate rapidly. The binder course was so thin that in many places the wearing surface appeared to be lying directly upon the surface of the old brick, which offered no contact. And as the surface cracked, large pieces of the surface asphalt would

become loose. The apparent weakness of this pavement was due largely to the insufficient thickness of the binder course and to the hardness of wearing surface, which appeared to have a penetration of about 35.

In 1913, Fayette St. for seven blocks from Adams St. to Knoxville Ave., was resurfaced with sheet asphalt over 30-year-old brick pavement. The old brick were laid upon a gravel foundation and were about 4x4x12 in. In many places they were disintegrated and would fall to pieces if removed. All depressions and inequalities in the surface were filled with binder course and brought to a fairly uniform grade. The surface was broomed at right angles to the center line and an attempt made to remove as much of the old filler as possible to provide an anchorage for the binder course. A splash coat of the asphaltic cement cut with naphtha was applied to the surface of the old brick, no attempt being made to completely cover the surface but merelyto spot it. A 1-in. binder course was then laid and rolled into place followed by a 1½-in. wearing course. After 10 years of constant heavy traffic, the surface is still in good condition, the city having spent nothing on maintenance to date, other than for repairs made by utility openings.

Main St. from Adams St. to Glen Oak Ave., 60 ft. wide, and Jefferson Ave. from Hamilton St. to Franklin St., 60 ft. wide, both double tracked and in the heart of the business district, were resurfaced in 1920 and 1921, respectively. In the resurfacing of Main St. unusual care was exercised in the cleaning and preparation of the old brick surface. At night the surface was flushed with a power flusher and all loose material removed. The Peoria Railway Co., the right of way being in bad condition and needing renewal, obligingly raised their rails 3 in. above the old grade along the entire length of the street and thus avoided the necessity of lowering the brick along the rails to provide for the new surface. Both streets were resurfaced in the same manner, a 1-in. binder course with a 2-in. wearing surface of sheet asphalt. All depressions and inequalities on the old brick surface were filled with binder course before the application of the binder itself.

In the resurfacing of Jefferson Ave., the Peoria Railway Co., claiming that the right-of-way was in good condition, refused to raise its rails to meet the new grade as established by the added thickness of the asphalt surface. It was necessary, therefore, to take up the brick along the track for a width of over 4 ft. and re-lay the brick upon the flat side after removing sufficient sand cushion, etc. The brick were relaid loosely with joints about ¼ inch wide, so that after

rolling and bedding them, the binder course squeezed into the interstices and held them firmly, thus offering an anchorgea for the paving surface. The removal of the old brick surface, while it is necessary along curb lines, around sewer inlets and manholes, and at street intersections adjoining other improvements, should be avoided where possible as the brick cannot be relaid as solid as they were in old pavement after years of constant traffic. Neither of these two streets have been down a sufficient time to predict the final result, but it is my opinion that the surface will show failure first where the old brick surface was disturbed.

Laying the sheet asphalt after the preparation of the surface of the old pavement is similar to any other asphalt pavement. The penetration limits of the asphaltic cement range from 45 to 50 on old resurface work and as high as 55 on residential streets with light traffic. On streets which are shady and protected by the overhanging trees from the sun, the penetration is raised to 60. Asphalt resurfacing here costs from $1.90 to $2.00 per sq yd. for the asphalt sheet including the binder course. The cost per running foot on each side of a 60-ft. street, exclusive of the right-of-way of the Peoria Railway Co., averages about $6.50. The whole cost of the improvement, including the relaying of the old brick, changing and altering sewers, curb corners, etc., and the paving of all street intersections, is charged to the property abutting the improvements, the city paying nothing. Prices on all styles of asphalt pavements have averaged lower here than elsewhere and cannot be used as a criterion by other engineers in making a comparison of prices in their respective communities. The fact that sand and gravel is found here in abundance, together with the fact that a local contractor here has a stationary plant suitable for such work, makes this condition possible.

The asphalt used here in all work done during the past 15 years has been Bermudez asphalt. The specifications were written exclusively for native asphalts, not because other brands were considered of inferior quality, but because the results obtained had warranted a continuance of their use. Our specifications then belong to the so-called class of "closed" specifications; closed because they are limited to certain specific brands of asphalt; namely, native asphalts. The public interests are protected by the laws of Illinois which permit of the acceptance of the lowest and best or responsible bidder. In the closed specification, while it limits the field to certain specific brands of asphalts and thereby limits competition, the public interests are protected by the spec-

ification which in advance limits the field to certain brands of asphalts which have a preference in the minds of the officials who have carefully considered the serviceability, etc., of the material selected. The same results, however, can be secured by the open specification, as it is not always the lowest bidder who secures the contract, but the lowest and best bidder, and in the end the asphalt having the preference with the officials may be selected, they having exercised the discretion sanctioned by the courts in the letting of public contracts.

"OPEN" *VERSUS* "CLOSED" SPECIFICATIONS FOR ASPHALT RESURFACING

BY C. R. ANDREW

First, I wish to define the words "open" and "closed" as applied to specifications in this portion of the discussion. By open specifications I mean specifications that are open in a practical and not a legal sense; specifications which will admit the products of a considerable number of competing firms, but not specifications which will necessarily admit all the products of all the firms supplying asphalt. By closed specifications I mean those specifications which are so written that they will admit the actual (not the possible) use of products of one firm or its subsidiaries. These specifications may be open in a legal sense, as it is possible that in other countries, or in other parts of this country, there may be independent firms manufacturing or producing a product which would fulfill the specifications, but in the particular case in question it would not be practical or perhaps possible for them to do so. With these two definitions in mind I will briefly give you the experience of the city of Decatur in obtaining bids under both "open" and "closed" specifications for sheet asphalt surface on both new work and resurfacing over old two course brick pavements.

In 1921 the city of Decatur inaugurated a considerable program of asphalt resurfacing. This program consisted of about 100,000 square yards of asphalt pavement, the majority of which was resurfacing over old brick, 80,000 yards of which was under contract during the season. This program was indorsed by the local Association of Commerce and various local clubs. The recommendations of the Association of Commerce were that the asphalt was to be equal to "Trinidad." Specifications were drawn which would practically permit the

use of no other asphalt than natural lake asphalt. The fact that no other asphalt was practical under the specifications is evidenced by the fact that when the bids were received none but Trinidad asphalt was bid upon.

The work consisted of closed binder, at least 1½ in. thick with a 1½ in. wearing surface over old brick surface. One project of about 15,000 yards was advertised. Five bids were received and the prices for that portion requiring asphalt were as follows: For 1½ in. binder and 1½ in. wearing course, from $1.74 to $2.155, and for extra binder $11.90 to $12 per ton. The engineer's estimate was $2.20 for asphalt surface and $12 per ton for extra binder. For reasons which were not of interest from a purely technical viewpoint, the commissioners decided to reject all bids and instructed the engineer to draw up specifications which would admit a larger number of asphalts; in fact, to write *open* specifications. This was done and four projects amounting to about 40,000 sq. yds. were advertised for bids. At this letting four bids were received, and the prices ranged from $1.20 to $1.73 for the asphalt surface, and for the extra binder from $10 to $12 per ton.

At the request of one of the leading firms supplying asphalt, a clause was inserted in the bidding blanks permitting the contractors to bid on more than one brand of asphalt. The lowest bidder submitted two bids; one using so-called oil asphalt, and another Trinidad Lake asphalt. His bid for Trinidad was $1.44 per sq. yd. Note that under closed specifications the lowest bid for Trinidad was $1.73. Under open specifications, using the same material, the lowest price was $1.44. Another point which may not be directly attributed to the effect of open specifications is that under open specifications the lowest bidder submitted lower prices for what we might call the accessories; that is, curb and gutter, drain tile, manholes, catch basins, etc. All of this meant a great saving to property owners.

Later in the season but before any work had been actually started, the remaining 40,000 yards was advertised and at this bidding the price for asphalt surface ranged from $1.35 to $1.65 and for extra binder from $10 to $12 per ton. This was all the bidding during the season and about 60,000 yards was completed, leaving 20,000 yards for work as soon as the weather permits, in the spring. I have made a tabulation of one of the projects to show the difference in the cost under the various bids received during the season. This particular project contained 14,787 square yards. Its actual cost, constructed under price obtained at third bidding, was

$36,604.90 or $2.47 per square yard. For this tabulation I have taken the actual amount of material used:

Lowest bid, closed specification	$42,147.23
Lowest bid, open specification, oil asphalt	33,652.05
Saving ($0.565 per sq. yd.)	$ 8,495.18
Lowest bid, closed specifications	$42,147.23
Lowest bid, open specifications, Trinidad	36,905.19
Saving ($0.35 per sq. yd.)	$ 5,242.04

DISCUSSION

Mr. Hittell.—All authorities agree that asphalt originates in petroleum, and there is no difference whether the asphalt occurs in solution and is obtained through a steel pipe, as in Mexico and the United States, or if it exudes through a fissure in the earth in the form of a heavy oil, and is spread over the savannah to a depth of from two to nine feet and an area of a thousand acres, as in Venezuela; or whether it issues through a mass of fine mineral matter contained in what is presumed to be the crator of an extinct volcano, as in Trinidad.

The dominant requirements of an asphalt cement are that it should be adhesive, cohesive, not vary too much in ductility under different temperature ranges, have permeability under all weather conditions, and otherwise be not affected by the elements. Who can say that the bitumen of any asphalt is superior over the others when these requirements are taken into consideration? In fact, the influence of the kind of bitumen as to its effect upon the character and the stability of the wearing surface has been greatly overrated. Mr. Wallace L. Caldwell, of the Pittsburgh Testing Laboratory, after an examination of the causes of failures of bituminous wearing surfaces, exclusive of failures due to foundations, states that those due to the unsuitability of the bitumen were but five per cent, the remaining causes being divided among the factors of workmanship, grading of the mineral aggregate, weather conditions, plant operations, and improper ductility.

In contravention of the word manufacture, there is no such article as a natural asphalt. To manufacture means to take a raw material and by some process make it a finished or useful article. The so-called natural asphalts, Trinidad and Bermudez, go through two processes before they can be

incorporated in a paving mixture. The first is that of refining wherein the light oils and extraneous materials are driven off as much as commercially possible, and the second when these refined asphalts are fluxed with a petroleum oil to make them into asphalt cements. Asphalts obtained from petroleum go through but one process, namely, that of driving off the lighter oils until the residue has reached the desired consistency.

Service and use, however, to a great extent determine the value of an article. Since the petroleum oil asphalts are put on a parity with the so-called native or natural asphalts by all the leading technical societies in the United States, every large city in the union, the State highway departments using asphalt, and the U. S. Bureau of Public Roads, and furthermore, since their consumption is about ten times that of the Bermudez and Trinidad combined, there seems to be no reason why those in authority should not adopt an open specification and reap the benefits of genuine competition, without impairing the quality of the pavement.

PREDICTING THE RESULTS OF DEEP WELL BORINGS

BY W. T. MCCLENAHAN

This paper is intended to show how an engineer may determine the yield and quality of water to be expected from a new well and how he may estimate the probable head which will prevail during pumping operations. It relates particularly to wells in the St. Peters and Potsdam formations.

Notwithstanding all the modern facilities for collecting, purifying and distributing water from lakes, rivers and impounding reservoirs, the large majority of people still obtain their water supplies from wells. In Iowa, Professor Norton estimates that fully 84 per cent of the people use water from underground sources. Since well supplies have been sought for so many generations it is surprising that there is still such limited knowledge of the location, source, movement and quality of underground water. However, since the discovery of oil in Pennsylvania and the subsequent development of the deep well drilling rig, our knowledge of the earth's structure has been extended and real advancement has been made in the science of geology and well drilling. We are particularly indebted to the careful and thorough work of the geological and water surveys of this and other states and especially of the United States, whose organizations have assembled and interpreted for general use all the available data from existing wells. Much of the information and

data in this paper has been taken from reports published by these various organizations.

In order to predict intelligently the results of drilling, the engineer must know something about the way the rocks were formed and how the water comes to be in them. In this paper, most attention will be devoted to the rocks of Illinois and Iowa. The great geological processes by which rocks have been made may be classified under six heads as follows: (1) Processes by which the original rocks were solidified from material in the molten state; (2) processes of major disturbances such as eruptions and great upheavals whereby the earth's structure was changed by warping, tilting, bending, fissuring, faulting, and remelting existing rocks; (3) processes of water action whereby rocks were dissolved, disintegrated, eroded, transported and precipitated in the sea, thereby forming new rock layers of conglomerate, sandstone and shale; (4) processes of lime secretion and solidification, processes which produced the great limestone beds; (5) carbon processes which produced the coal, oil and gas strata; (6) glacial processes which changed the topography and ground the rocks under heavy ice sheets.

Let us consider some of the ways in which these processes affected the storage and quality of ground water.

A. Original rocks consisting mostly of granite are ordinarily not filled with water. Occasionally, however, some water is found in the crevices and disintegrated portions of such work. This water is usually quite soft.

B. Water collects in more or less abundance in the great synclinal basins resulting from rock upheaval so that large natural reservoirs for water are provided. If a porous layer in such a basin be covered by an impervious shale or other tight rock, and water enters the porous stratum at a sufficiently high elevation, flowing wells may result from penetrating the upper layers.

C. Conglomerates, sandstones and shales were the result of the selective classification of eroded material which had been dumped into the sea by heavily laden streams. The conglomerates and sandstones are for the most part water-bearing, but the shales are invariably dry. Water from these stones may be slightly mineralized, the nature and amount depending upon the kind of sandstone in which the water is found and further as affected by other water from neighboring strata.

D. Lime secretions began late in the Cambrian age. As a rule, magnesium rocks are more porous and fissured than

are calcium rocks and, therefore, they hold more water. Water from such rocks is, of course, quite hard, and the proportions of magnesium and calcium may be expected to bear a close relationship to the composition of the rocks themselves.

E. The coal deposits are apt to be rich in sulphur and sulphur compounds and in the anticlinal domes of this series some oil and gas may appear. There is, therefore, little water in the so-called "coal measures" that is fit for domestic use and very often no dobut water from these measures unfavorably affects the water from other horizons that normally yield good water.

F. Water from the glacial deposits is usually rich in iron and is sometimes quite hard.

Thus, knowledge of the formation of the rock in which the water lies helps to determine the probable quality and yield of a new well. The question as to how the rock holds the water is interesting. It is found in seams, in cracks, in crevices and sometimes in great caverns, but most of all it is held in the pores and voids of the rock itself. Professor Van Hise has shown that crevices and voids which can hold water cannot exist below a depth of more than 5 or 6 miles, since the great weight of superimposed rock coupled with the great heat at those depths causes the rocks to creep and flow together to form a dense, solid mass. On this basis Professor Slichter has estimated that about one-third of the water of the earth is held beneath the surface as ground water.

No doubt water falling anywhere upon the earth penetrates to some extent all overlaying strata, but since some of the upper strata are quite impervious, the question arises as to how the great quantity of water gets into the underlying layers. The principal source of this supply is not directly from above, but through the upturned edge of the porous layer where erosion or glacial action has exposed it to rain and surface water. An example of this is the outcroppings of the St. Peters and Potsdam sandstones occurring mostly in Wisconsin. From these outcrops in Wisconsin the water travels slowly down through the inclined strata reaching great depths in central Illinois.

Under normal conditions water will not rise higher in a well which penetrates one of these inclined strata than the elevation of the low part of the outcrop. In fact, experience seems to show that the static water level usually falls as the distance from the outcrop increases. This, however, is not always the case, as for instance certain wells in northern Illinois drilled into the St. Peters sandstone have shown

higher levels than the low parts of the outcrop. The surface of this outcrop in Wisconsin is largely below elevation 800 ft. above sea level; some of it is little more than 600 ft. above sea level. Yet the original static level in two wells at Dekalb stood 772 ft. and 800 ft. respectively above sea level; a well at Harvard stood 894 ft., and one at Amboy 781 ft. above datum. The reason for this phenomenon is not apparent but it is thought to be due to leakage of water through intervening layers which are generally impervious from another stratum under high pressure. The effect is to build up a local head on the St. Peters rock in the neighborhood of the well. This explanation may also account for some of the variation in the quality of water from St. Peters wells.

The thickness of the St. Peters sandstone is quite variable. It was laid down on a deeply eroded bed of limestone which even in the same region makes a considerable variation in the sandstone thickness. This is illustrated by the Chicago district as shown in Table 1 where the thickness ranges from 89 ft. at Crown Point to 420 ft. at South Evanston. This table is from "Water Resources of Illinois," by Frank Leverett. Since the yield is a function of the rock thickness it follows that the thickness of the bed has an important bearing on the yield and should be carefully determined and reported for the benefit of others who may subsequently seek water in that stratum.

Potsdam and St. Croixan are names applied to a series of water-bearing strata lying below the Prairie du Chien group of dolomites, the best known layers of which are the Jordan sandstones, the St. Lawrence dolomite, the Franconia, the Dresbach, the Eau Claire, and the Mt. Simon sandstones. In northern Illinois, this series of strata probably attains a thickness of one thousand feet or more.

In most places the texture of the St. Peters rock is rather clean and coarse, being formed from uniform, rounded grains of quartzite about one-eighth to 1 millimeter in diameter. The sand is of such nature that is is mined in some places for the manufacture of glass. The texture of the Potsdam group of rocks is generally finer and more thoroughly cemented together than the St. Peters rock and the sand grains are also more angular and less worn.

Water from the St. Peters rock is generally high in sulphates and may even contain hydrogen sulphide in appreciable quantities. It also tends to be quite hard, as the St. Peters stratum lies between two layers of limestone either or both of which may be water-bearing. If the Potsdam layers are

TABLE 1--Records of Wells in and around Chicago

Location	Distance between adjacent walls.	Elevation of curb.	Top of Niagara	Thickness of Niagara.	Contact between Niagara and Hudson River shales.	Thickness of Hudson River shales.	Contact between Hudson River shales and Trenton limestone.	Thickness of Trenton	Contact between Trenton and St. Peter sandstone.	Thickness of St. Peter sandstone.	Contact between St. Peter sandstone and marl or shale.	Thickness of marl or shale.	Contact between shale and Lower Magnesian limestone.	Thickness of limestone, sandstone, etc., below St. Peter sandstone.
	Miles	Feet	Feet	Feet										
1. Lake Bluff	0	682	475	320	155	198	*43*	216	*259*	167	*426*	32	*458*	46
2. Highland Park	8	695	520	400	120	200	*80*	240	*320*	200	*520*	50	*570*	935
3. Winnetka	6	658	474	316	158	192	*34*	247	*281*	212	*493*	45	*538*	470
4. South Evanston	7	612	540	260	280	230	50	270	*220*	420	*640*	14	*654*	336
5. Chicago and Western Aves.	10	612	612	395	217	148	69	157	......	......	......	....	......	......
6. Union Stock Yards	5	595	500	254	246	250	*4*	325	*329*	155	*484*	0	*484*	70
7. Morgan Park	10	640	477	......	......	......	......	......	*405*	......	......	....	......	......
8. Hammond	10	600	490	......	......	......	......	......	*460*	190	*650*	0	*650*	650
9. Crown Point*	15	736	484	433	51	*234*	*183*	342	*525*	89	*614*	0	*650*	15
Average	....	......	......	......	......	207	......	273	......	205	......	....	......	......

*At Crown Point the shales above the Trenton are separated into two beds, between which is a bed of limestone 57 feet thick, thought by Dr. Phinney to be Clinton limestone. This section also includes Devonian shales, and possibly Devonian limestone. The thickness of the Niagara may therefor, be less than indicated above.

Italics represent altitudes below sea level. Authorities: 1 and 3, Gray Brothers, drillers; 2, John Peterson, driller; 4, Dr. Oliver Marcy; 5, W. T. B. Read; 6, Dr. H. M. Bannister; 7, W. S Gamble, C. E.; 8, W. F. Bridge, C. E.; 9, Dr. A. J. Phinney.

not penetrated too deeply the water is likely to be less highly mineralized and generally softer than the St. Peters water. However, the saline content usually runs higher, appearing to increase with the depth of the well. The reason for this increase in salt as the depth of the well increases may be the higher specific gravity of salt water.

A matter often requiring attention is the approximate depth necessary to reach St. Peters rock. Contours of the top of the St. Peters rock in Illinois and Iowa show that the stone slopes gently to the south and southwest from the area of outcrop in Wisconsin. The most noticeable feature is a decided fold in the layer beginning north of LaSalle and extending in a southeasterly direction toward the oil fields of Crawford county. An abrupt change in the elevation occurs at this line amounting to as much as 1,000 ft. near LaSalle, so that wells west of the line are considerably deeper than those east of it. A number of synclinal basins head up toward the Wisconsin border in which basins lie the great coal fields of Indiana, Illinois and Iowa. Oil and gas are found in the anticlinal domes where they have been driven by water from beneath. Few good deep wells exist in this coal, oil and gas territory.

In estimating the depth of a well to St. Peters sandstone, it is necessary to know the sea level elevation of the surface of the ground at the site of the well and by use of the contour map and a simple subtraction the depth of the well to rock can be computed. In this way the Iowa Geological Survey has been able to predict the depth of wells in virgin territory to within 50 feet of the depth actually found. No such map has been constructed for the Potsdam layers and the data upon which it would be based are insufficient at the present time. The reader should bear in mind that static water levels are elusive and fleeting. For a number of years, static water levels around Chicago have been falling at an average rate of about seven feet per year and the indications are that other wells about the state are having and will continue to have much the same experience, but of course in a lesser degree than at Chicago as more and more wells are drilled into the stratum.

To increase the yield of a well, drillers sometimes set off a heavy charge of nitro-glycerine opposite the stratum from which water is to be taken. The effect of this shot on rocks of the nature of the St. Peters is to create a large hole into which water flows more freely, as the larger surface area of the blasted hole affords easy access to the well. Other things being equal, the yield is estimated to vary about as

2½ times the diameter of the hole. It is evident, therefore, that a large hole produced by an explosion in the water bearing the stratum is equivalent to drilling a large hole all the way down from the surface at a very much less cost. However, not all wells are successfully shot and some have even been destroyed by the explosion. Professor Norton strongly condemns the practice for Iowa on the ground that the blasting of the St. Peters rock in this way causes the sand to run and continue to cave long after the well has been cleaned out and finished ready for use, eventually filling up the hole and putting the well out of service. Nevertheless, many wells are now being shot in this way with apparent success.

The yield of a stratum depends on the extent and thickness of the layer and on the velocity of the flow of water through it. The velocity of flow through rocks except through fissures, crevices and uncemented gravel is very slow. Professor Slichter has estimated that for a sand bed having a hydrostatic slope of 10 feet per mile (which slope is very common for the St. Peters sandstone) the velocity of flow will be about as shown in Table 2.

TABLE 2.

	Flow; feet per year	Flow; cu. ft. per min.
Fine sand, 0.2 m.m. dia.	52.8	2.75
Medium sand, 0.4 m.m. dia.	216.0	11.00
Coarse sand, 0.8 m.m. dia.	845.0	43.50
Fine gravel, 2.0 m.m. dia.	5386.0	273.00

For other slopes the velocity of flow varies about as the slope per mile. Professor Slichter also estimates that the quantity of water flowing through 100,000 square feet of sand in vertical cross section, on a slope of 10 feet per mile, with a porosity of 32 per cent will be about as shown in the right hand column of Table 2. For estimating the flow through sands of other porosities than 32 per cent he gives the following:

Per Cent of Voids	Relative Flow	Per Cent of Voids	Relative Flow
30	0.81	36	1.47
32	1.00	38	1.76
34	1.22	40	2.09

Therefore, if the layer thickness and extent be known, if its porosity and grain size be determined and if the hydraulic slope be ascertained and these things be uniform throughout the whole sand bed, close approximation can be

Table 3. Deep Well Records

City	Size in inches		Depth—feet	Rock penetrated	Depth to water		Pumpage		Source of information	Kind of pump
	Top	In rock			Start	Pumping	G.P.M.	M.G.D.		
Monmouth	8	7½	1222	St. Peters	162	277	....	....	Observation	Air
Monmouth	10	8	1230	St. Peters	......	......	....	....		Air
Monmouth	9, 7	5½	1227	St. Peters	......	......	....	....		
Kewanee	4, 6, 8	..	1460	St. Peters	......	......	1040	1.50	Ill. Inspection Bur.	Air
Galesburg Brad. No. 1	24–12	10	1251½	St. Peters	187.5	308	425	.61	Am. Well Works	(shot) Air
					......	334	502	.72	Am. Well Works	Air
Galesburg Brad. No. 2	16–15	14	1245	St. Peters	190.0	347	650	.94	Am. Well Works	(shot) Air
	26–11	10	2414	Potsdam	156.0	204	1250	1.80	Am. Well Works	Cent.
	......	..	....	....	......	212	1450	2.10	Am. Well Works	Cent.
Galva	14⅞	8	1525	St. Peters	275	293	300	.43	Mayor to Luitweiler	Air
Canton City		..	1646	St. Peters	50	......	417	.60	Ill. State Water Survey	Air
Canton City		..	2042	Potsdam	50	......	....		Ill. State Water Survey	Air
Canton Int. Har. Co.	10	6	1727	St. Peters	80	......	200	.29	Ill. State Water Survey	Air
Brookfield	18	8	2200	Potsdam	15	90	700	1.00	E. Hancock	Cent.
Buda	8	6	1600	St. Peters	......	150	100	1.44	P. M. Weinstein Luitweiler	Well head
Aledo		8	1450	St. Peters	100	......	240	.32	Ill. State Water Survey	Air
Viola	10	6	1281	St. Peters	175	......	180	.26	Ill. State Water Survey	
Alexis	10	4	1209	St. Peters	70	......	70	.10	Ill. State Water Survey	
Woodhall		6	1394	St. Peters	200	......	....	....	Ill. State Water Survey	
Knoxville	8	6	1350	St. Peters	187	......	130	.19	Ill. State Water Survey	Air
Abingdon	9	6	1350	St. Peters	170	216	130	.06	Ill. State Water Survey	Air
Stronghurst		6	1009	St. Peters	65	......	100	.006	Ill. State Water Survey	

TABLE 4--Analyses of Deep-Well Waters in Vicinity of Monmouth, Ill.

City	Direction and miles from Monmouth	Total depth of well	Depth cased	Pumpage—gals. per 24 hours	Total solids	Mineral Analyses — parts per million: Magnesium	Calcium	Chloride as Cl	Sulphate as SO^4	Carbonate as CO^3	Iron	Analysis made by	
Alexis	NE-11	1204	600	100,000	969	33.5	63.3	93	335.2	290	7.0	A	1915
Alpha	NE-24	1365	....	6,000	1053	20.5	52.3	225	288.0	240	0.2	A	1917
Abingdon	SE-15	1353	....	60,000	1036	36.0	75.2	115	393.4	171	0.7	A	1901
Abingdon	SE-15	1353	....	....	1311	47.0	90.0	150	265.0	250	0.3	B	1919
Aledo	N-21	3165	to rock	350,000	2070	35.0	120.0	......	171.0E	266	0.0	A	1914
Aledo	N-21	1450	to rock	350,000	1746	27.0	96.0	......	110.0E	210	0.2	A	1918
Bushnell	SE-25	1351	....	....	2042	49.6	112.0	392	680.8	183	3.8	A	1898
Bushnell	SE-25	1351	....	....	1880	47.5	97.6	......	146.3E	173	0.8	A	1919
Galesburg	E-16	1500	....	....	1455	38.6	83.2	157.5	664.4	8	0.4	A	1899
Galesburg	E-16	2414	573	18 M.G.D.	1053	26.0	56	......	......	......	0.3	A	1921
Galesburg	E-16	1255	1090	650,000	1690	48.0	104.0	......	145.0E	......	0.3	A	1921
Galesburg	....	1252	1090	935,000	....	----	-----	......	......	......	--		....
Knoxville	E-22	1350	1056	....	1168	30.0	64.0	......	......	......	0.4	A	1920
Roseville		....	....	....	....	----	----	......	......	......	--		
10 min. pump	S-13	1350	500	....	543	4.0	......	......	0	228	0.0	A	1921
15 min. pump	S-13	1350	500	....	1050	26.0	......	......	0	244	0.6	A	1921
105 min. pump	S-13	1350	500	....	2527	87.0	......	......	682	223	1.4	A	1921
Stronghurst	SW-17	1009	....	6,000	2954	110.0	263.0	......	862	......	4.0	A	1921
Stronghurst	SW-17	1600	1056	6,000	1486	51.0	91.0	......	806	......	2.2	A	1919
Viola	N-20	1281	....	4,000	1140	26.0	29.0	......	......	......	1.1	A	1921
Woodhull	NE-26	1394	....	....	929	15.0	42.0	......	......	......	0.6	A	1921
Burlington, Ia.		1000	....	....	3206	115.0	342.0	235	1860	229	1.0	C	1912
Burlington, Ia. F		2430	....	....	1066	25.0	79.0	161	386	270	..	C	1912
Monmouth		1230	600	450,000	1230	37.6	4.5	149	614	65	0.0	D	1916

A—Illinois State Water Survey. B—Illinois State Department of Public Health. C—Iowa State Geological Survey. D—Dearborn Chemical Co. E—Magnesium sulphates. F—Samples tested after passing heater, which undoubtedly precipitated much of the carbonate.

made of the probable yield of a new well. Most often, however, some or all of these elements of estimation are unknown or uncertain and we must rely on other less scientific means for predicting the yield of the well.

What practical method then can an engineer use for predicting the yield and quality of water resulting from deep well drilling? A method which has been found useful has been to spot existing wells in the vicinity of the proposed well on a map of the surrounding district, marking the distance of each well, and its depth and mineral content. Table 3 gives similar data regarding the pumping rate of wells near Monmouth together with the heads recorded and other information. Table 4 gives chemical data and information regarding the manner of casing each well so far as that was known. With such a map and tabular data before him an engineer forms his judgment on comparative facts rather than on mathematical determinations. For instance, in the case of Monmouth, it was concluded that a well into the St. Peters rock, if successfully shot, might yield as much as 500 g.p.m with a pumping lift of about 350 feet. It was thought that the water might contain from 1230 to 1500 p.p.m. of mineral solids, depending on the care with which the well was cased and somewhat on the annual pumpage.

Although the information was inconclusive on account of the small number of wells of the kind in the vicinity, it was in like manner reasoned that a Potsdam well 2.400 ft deep might yield 1200 g.p.m. with a lift of about 220 feet. A mineral content for such a well of 1050 to 1150 p.p.m. was predicted. In considering the evidence for mineral content in the Potsdam well, the Aledo well was disregarded as being inconsistent with other data, either because the well was drilled too deep or on account of improper casing.

This method of predicting the yield and quality of water from a new well may therefore be described as a weighing of the evidence from other wells. With good engineering experience and good judgment, it serves the purpose until a better method is devised. However, in order that the prediction should be reasonably accurate, it is evident that the information upon which judgment is based must be accurate. Unfortunately, this is not always the case because there has been no real incentive in the past for keeping accurate well records and the states have not had sufficient organization or authority for obtaining the necessary data in reliable form.

Most well data are based on scant personal records and often on the memory of well drillers or others who may or may not have had a clear conception of just what is important.

Some of the things that need to be done and to be reported for general information are as follows:

1. Drilling samples should be taken every 5 feet and at every change of formation. These samples should be carefully preserved in glass jars and labeled with the depth of sampling. Analysis of the rock samples should be made by the State.

2. Frequent water samples should be taken during drilling operations so as to secure a mineral analysis of water from all of the water-bearing strata encountered. The samples should preferably be analyzed by the State.

3. Frequent water levels should be taken in the well during drilling operations, so as to indicate roughly which strata yield water under high heads and which strata are unproductive or even robbers of water obtained from other strata.

4. Careful record should be made of the drilling methods and the manner of casing the hole. It is important to report the manner of shooting the well. Such reports should be in sufficient detail that an engineer may know what horizons of water were utilized and which were shut off, and that he may judge of the merit of the drilling and shooting methods, and secure data regarding the value of different materials used for casing. A record of any test of capacity made by the driller is likewise pertinent.

5. Careful record should be kept of the annual pumpage, together with the static and operating water levels prevailing in the well, if they can be ascertained.

6. An annual or biannual analysis of the water from a well is of value, for such analysis would show marked changes in the mineral content of the water. Such changes indicate either that the casing is leaking or that some change is taking place in the stratum itself.

7. Repair records such as casing and eductor pipe renewals, sand removal (or well cleaning) and the like are valuable history and should be kept.

If the State were to furnish blank forms and instructions for sampling to all drillers and well owners before any drilling work was started and then were to insist upon accurate reports from these men, better records would result. In whatever way the reports are obtained, the State, if it can see its way clear to secure the necessary appropriation, should have some kind of a supervisory power for securing the information that is really needed and should work up the data in reports suitable for general use.

WATER SUPPLIES FROM GRAVEL DEPOSITS

BY G. C. HABERMEYER

Peoria and other municipalities secure public water supplies from sand and gravel deposits in the valley of the Illinois River. From Ottawa through LaSalle to near Bureau the river flows westward and then turns and flows southwest and southward. Three miles down stream from the bend, Hennepin secures a highly mineralized water from a well into rock. Below Hennepin, to the mouth of the river, all municipalities located along the stream that have a public water supply, secure water from these sand and gravel deposits. The municipalities are Henry, Lacon, Chillicothe, Peoria, Pekin, Havana, and Beardstown. At all of these places water is drawn from wells 30 to 90 ft. deep by pumps which discharge directly into the distribution systems. The pumps are generally in pits deep enough to avoid excessive suction lifts.

Mr. Crozier, engineer and superintendent of the Peoria Water Works Co., described the Peoria water works when we were here in 1914. The main well, 34 ft. in diameter, from which the high service pumps draw, does not furnish sufficient water and additional water is discharged into a tank in this well by centrifugal pumps located in other wells and in four caissons in the bottom of this main well. All but one of the wells at other places (one at Henry) are from 4 to 8 in. in diameter.

At Henry, water is secured from three wells, each about 40 ft. deep. Two of these are 8 in. in diameter, about 8 ft. apart, and equipped with Johnson's screens 8 ft. long. The other well is 8 ft. in diameter and about 10 ft. distant. The last pump installed is an American centrifugal pump of 500 gallons a minute capacity operated by electric motor. At Lacon, water is secured from two 8-in. wells about 6 ft. apart, each about 60 ft. deep. Water is pumped by two American two-stage centrifugal pumps, of 200 gallons a minute capacity, each with suction pipes extending into the wells. At Chillicothe, water is secured from ten wells about 60 ft. deep, located in a space 10 by 45 ft. Six of the wells are 6-in. and four are 4-in. diameter; all equipped with screens about 10 ft. long. The pumps usually used are electrically operated triplex pumps, the larger of which is an 8x10-in. Platt Iron Works pump of 350 gallons a minute capacity.

At Pekin, water is secured from 22 wells; 19 are in a pit 29 ft. diameter and the other three are in a pump room nearby. They are equipped with screens of various makes,

the bottoms of which are nearly all 70 to 85 ft. below the surface. The two largest pumps are Blake compound duplex pumps, 12 and 22 in. by 12 in. by 18 in. of about 1,500,000 gallons daily capacity each. Demands of about 800,000 gallons a day are supplied, drawing the water level down about one foot. At times water under pressure is applied to the wells and about once a year they are sand pumped. At Havana, water is drawn by suction from ten 6-in. wells, 72 ft. deep, equipped with Cook screens 20 ft. long. The greatest distance between any two wells is 40 ft. Water is pumped by either of two Deane compound duplex steam pumps 12 and 18½ in. by 12 in. by 10 in. at a rate of 500 to 600 gallons a minute. At Beardstown, water secured from twelve 6-in. wells has a high iron content and considerable trouble has been experienced with clogging of screens. Wells have been sunk to depths of 40 to more than 100 ft. in an attempt to secure water with a low iron content. At one time 72 wells 2 in. in diameter were in use and each was to be pulled up every two years to renew the screen. Screens on larger wells have been cleaned by compressed air and by steam pressure. In 1920 ten of the wells were pulled up and replaced with the bottom at a depth of 72 ft.

Nearly all samples of water from these supplies that have been analyzed, excepting those from Havana, have had a mineral content of from 400 to 500 and a hardness of 300 to 400 parts per million. Samples from the Havana supply have had a mineral content of about 200 and a hardness of about 160. These supplies, excepting that at Beardstown, contain but little iron.

MECHANISM OF THE ACTIVATED SLUDGE PROCESS FROM THE CHEMIST'S STANDPOINT

BY A. M. BUSWELL

At the present time there are two rather opposing theories for the explanation of this process. The Hampton doctrine on sewage filters Ardern summarized as follows: "According to the theory the purification process is primarily and essentially a dessolution effect brought about purely by physical causes and that any bacterial or biological action is definitely ancillary." Those favoring this theory compare the action of activated sludge and of the jelly in sewage filters to that of coagulated alum floc. The other or biological theory was probably first proposed by Dunbar. Evidence in support of this theory presented by the writer to the American Water

Works Association (see "Journal" of the Association, March, 1923) makes it seem reasonable to conclude that sewage treatment in activated sludge tanks and on trickling filters is similar to that of the disposal of garbage by feeding it to hogs. Microscopic and mechanical study of activated sludge indicates that the flocs are composed of communities of various micro-organism which eat up the organic matter in the sewage and re-synthesize it into living microbial protein. The present discussion will be based upon the assumption that this viewpoint is correct.

Since the activated sludge process involves the cultivation of certain growths using sewage as a culture medium a review of the information concerning the conditions necessary for such cultivation will be interesting. The process was at first discovered by blowing air through sewage, but it was early apparent that on a large scale this would be comparatively expensive. Many attempts have been made to replace air by mechanical agitation. The Brosius and the Trent aerators, employing somewhat different mechanical means, accomplish a combination of aeration and stirring by means of drawing down a mixture of sewage and air through a pipe just below the level of the sewage in the tank and returning it to the bottom of the tank. Various mechanical agitators and agitator aerators were employed by Nordell. In another type of aerator experimented with by Coulter, the sewage flows through a jet under pressure, striking the surface of the liquor in the tank at a relatively high velocity and carrying in a considerable amount of air. Brosius used a central downward suction to produce a mixture of air and sewage and produce circulation, while Trent employed a type of tank using a centrifugal pump to draw down a mixture of air and sewage and return through the revolving nozzles in the bottom of the tank. None of these devices were successful in producing and maintaining activated sludge.

The Simplex aerator produces an upward velocity in a central tube by means of a propellor which throws the liquor out in a sheet from the saucer-shaped upper portion of the central tube. This process is said to be in successful operation at Bury, England. The economy of this type of tank, however, is not definitely proved. Haworth has been operating a mechanical circulation plant at Sheffield, England, in which the sewage flows back and forth through long channels 4 ft. wide and 4 ft. deep, the velocity being produced by paddle wheels placed at mid length. While Haworth is able to maintain the activated sludge process by means of this device, he requires just about as much area as is required for tanks and filters.

In the article describing the agitators referred to above, Nordell states that the growth of the sludge demands so much air that in supplying this all the agitation necessary will be supplied and that any form of mechanical agitation will be superfluous. His conclusions seem to have been rather generally accepted in this country and have tended to discourage experimental work along this line. After microscopic investigation of the organism occurring in activated sludge we are inclined to question Nordell's conclusions.

The organisms which we see in activated sludge we have also seen growing in stagnant pools and ditches and along polluted streams where we are sure the oxygen available was far below that which seems to be necessary for the activated sludge process. This observation leads to the very pertinent question as to whether oxygen is as essential to the success of the activated sludge process as it is now considered to be. We are unable to find any direct evidence on this point, because in every case the air blown into the sewage or the mechanical force applied as in Haworth's case was producing several different effects, any one of which might be of fundamental importance to the success of the process.

When air is blown into the aeration chamber of an activated sludge plant it does three things: (1) It maintains the sludge in suspension; (2) it maintains aerobic conditions; (3) it stirs up the mixture, allowing fresh liquor to come into contact with the sludge. We are not able to tell which of these factors determines the critical minimum air requirement. In Haworth's process we also have the three factors determining the critical velocity (1½ ft. per second) which he found necessary to maintain in his circulating chamber. The importance of maintaining the sludge in suspension depends upon the fact that otherwise the sludge could not come into contact with the liquid, and that if the sludge is allowed to stand it very soon begins to putrefy and the work done in building it up is lost. In other words, the reaction starts to go on around a lap or two on the spiral.

The relative importance of aerobic conditions and stirring cannot be balanced by means of present data. Accordingly we have undertaken an investigation to determine the minimum air requirement of the microbial growths composing the sludge. To do this it was necessary to hold one at least of the three variables constant, thereby allowing us to balance the other two. We decided upon adopting some mechanical means for maintaining the sludge in suspension, thereby making it possible to balance the relative importance of stirring and oxygen requirement and to obtain data on critical

stirring velocities and minimum oxygen necessary for biological growth.

In the first experiments, racks were dipped in and out of the tank containing the sewage, thereby producing aeration and stirring at the same time. The amount of oxygen introduced in this method was determnied by observing the rate at which water containing 0 dissolved oxygen became aerated when substituted for the sewage. It was impossible to determine the rate of aeration of the sewage directly, since some of the oxygen is used as fast as it is taken in. In another set-up we provided our tank with a filtros plate in the bottom and a rotating Nidus rack. Experience with the dipping rack had shown that the amount of air required was comparatively small. We therefore arranged to feed air in very small quantities by means of an aspirator bottle, a common apparatus in chemical laboratories. As a result of several such experiments we were able to produce an abundant growth of sludge and a very good clarification and a substantial purification of sewage in from three to six hours and using as low as 0.002 cubic ft. of air per gallon. In other words, as long as sludge is not allowed to settle in the bottom of the tank and putrefy and as long as circulation is maintained activated sludge will grow and develop at oxygen levels so low that they can scarcely be measured. Stirring is apparently very much more important than is oxygen.

If we consider the various steps which must take place in the activated sludge process it will be apparent why stirring is of such great importance. There are apparently four important points involved in this process: (1) The water surface; (2) an activated sludge floc; (3) a colloidal particle of organic matter; (4) a dissolved molecule of organic matter.

We shall discuss the process in terms of six reactions. In the first place, the air must saturate the liquor or water immediately below the surface of contact. Langmuir has shown that enough molecules strike such a surface to saturate it in an infinitesimally short time, giving a thin layer of water saturated with oxygen immediately in contact with the air surface. Second, this oxygen must then diffuse to the activated sludge particles. This is an exceedingly slow process as was pointed out over twenty years ago by Noyes and Whitney and later emphasized by Phelps. Third, the dissolved molecular organic stuff must diffuse to the activated sludge particles. This also being a diffusion process is slow. Fourth, the colloidal particles must get to the activated sludge floc somehow or other. The actual change of position of colloidal particles is practically 0. Fifth, the organic material and the oxygen must be taken up and worked over by the

organisms of the sludge floc. As far as we are able to tell this is a comparatively rapid process. Sixth, the by-products of the biological growth must diffuse away from the sludge floc, otherwise they will accumulate and poison it.

Thus we have six steps which must take place in a process and all except 1 and 5 are comparatively slow. The only way that we can speed up the other four steps is by stirring, which will sweep away the saturated film from the air surface and bring it down in contact with the activated sludge particles. It will move the dissolved and colloidal organic matter about so that they come in contact with the floc and will sweep away the metabolic products of the sludge organisms. In view of this analysis it does not seem so strange that stirring should prove to be more important than air in the carying out of this process. Stirring by means of blowing air through sewage si a rather inefficient process. We do not get as much stirring for the power input as we would if the power were applied in some other way. When air is blown into sewage in activated sludge flocs, air bubbles and liquid are driven in the same direction. The most efficient process would be one in which the air surface and flocs would be held stationary while the liquor be caused to flow past them. The experimental apparatus which we have used approaches some such condition and it is for that reason that we were able to obtain the results described.

STATUS OF SEWAGE DISPOSAL IN ILLINOIS

By Paul Hansen and Harry F. Ferguson

Because of increasing demand for cleaner streams and present activity in providing for better sewage disposal, as evidenced by the formation of a number of sanitary districts in Illinois within the past few years, it has been deemed advisable by the Sewerage Section of the Illinois Society of Engineers to have a report giving the status of sewage disposal in the State. Table 1 gives a list of sewage-treatment plants so far as information has been obtainable, arranged in groups for cities and villages, and for Federal, State, county and private institutions. In Table 2 are listed the various plants according to type.

The largest group comprises single-story tanks only, numbering 62 and serving a total population of approximately 255,000. Many of these tanks effect some improvement in the streams over the condition that would result from the discharge of crude sewage and these are listed as O.K. But

as a matter of fact, few of them receive any attention. All of them would probably give better results if they were looked after systematically.

There are 8 plants serving a population of 29,300, involving single-story tanks and either percolating or sprinkling filters. The term "percolating" indicates those filters where some form of trough arrangement is used as contrasted with sprinkling nozzles to distribute the sewage on the filter. All of these plants now in operation are more or less neglected; some of them almost totally neglected. Many of them are decidedly overloaded and none of them are producing satisfactory effluents. The plant at LaGrange is out of service altogether. This plant has a well-designed dosing chamber and sprinkling filters and is supposed to receive sewage from a prior existing septic tank some distance away. A small sewer was laid along the side of a large storm sewer in order to convey the septic-tank effluent to the treatment plant. The construction of the sewer, however, was so poorly carried out that the sewage from the small sewer leaks into the large sewer and escapes into the stream. Thus it is impossible to deliver sewage to the sprinkling filters. This plant has been taken over by the Chicago Sanitary District and plans are under way to again place it in operation.

There is but one plant comprising a single-story tank and contact beds, namely, at Polo. In this case, however, the contact beds have been abandoned and the only treatment which the sewage receives is in the septic tank. Until recently there was a similar plant at Chicago Heights and this plant was generally neglected and never gave a satisfactory effluent. It has recently been remodelled so that it now comprises two-story tanks and sprinkling filters.

There are 10 plants serving a population of 19,700 comprising one-story tanks and intermittent sand filters. Only one of these has received systematic operation; namely, that at Harvard. This plant, until it became overloaded, has always produced a good effluent and continued to give a good effluent even after the loading was larger than ordinarily considered good practice for such filters. The other plants have been more or less neglected. The sand filters at Woodstock, for example, have been so completely neglected that it is difficult to find them on account of the heavy growth of weeds. To this group might be added the plant at Mendota, which comprises intermittent sand filters, but no preliminary treatment of a substantial nature. Some sedimentation, however, takes place in small crude tanks adjoining each filter. These tanks are simply excavations with sides protected by wooden sheeting.

In connection with country clubs, there is a demand for some form of treatment which will be simple and will not expose sewage to view and this has led to the adoption of plants including some form of tank treatment followed by subsurface irrigation in prepared beds of sand. This represents an effective installation if the sand areas are made large enough. Plants of this type involving single-story tanks have been installed at Calumet and Northmoor country clubs and at Arden Shore, a charitable institution giving summer outings to children of the poor. They serve a total population of about 800.

Twelve towns, having a total population of 30,200, have adopted treatment by two-story tanks only. The popularity of the two-story tank seems to be developing even for small installations. It is not apparent that these tanks receive any more attention than the single-story tanks, although it is generally recognized that they will not operate properly unless they receive some attention at least once a week. So far as known, most of these tanks are removing a substantial percntage of the settleable solids, but some of them are giving poor results because of utter neglect.

Where dilution is available and it is merely desired to protect water supplies or bathing beaches from excessive sewage pollution, two-story tanks with chlorination of the effluent have been looked upon favorably. The first plant of this type was installed at Moline in 1913 to protect the water supply against a small portion of the city which discharges its sewage into the Mississippi River above the waterworks intake. This plant has been partially neglected and when inspected several years ago the chlorine apparatus was not in operation. Three additional plants of this type are being installed for the North Shore Sanitary District at Lake Bluff and Highland Park. These are intended to protect the bathing beaches and should receive good operation under the sanitaray district organization. The total population served by this method is about 8,800.

Tanks of the two story-type followed by sprinkling or trickling filters have been used or are now under construction in 15 places serving a population of about 191,400. An additional plant of this type is contemplated for the near future at Urbana-Champaign. As already noted, one has just been completed for Chicago Heights and another placed in operation late in December, 1922, at Downers Grove for the Downers Grove Sanitary District. A small area of sprinkling filters is incorporated with the new Calumet plant of the Chi-

cago Sanitary District. These filters have not yet been placed in operation.

All except the plants at Chicago Heights, Downers Grove, and Morton Grove are of the percolating or roughing filter type. They have, for the most part, been neglected and overloaded, and have not been giving good results. At present the Chicago Heights plant is under efficient operation and is giving a good effluent. The effect of this plant, however, on the stream is more or less negatived by the fact that considerable industrial wastes are discharged into the same stream without treatment. At Downers Grove the plant is in charge of a man whose sole function is to look after its operation. He has no special qualifications for this work and it remains to be seen if he can obtain good results after being properly instructed. The Morton Grove plant is within the Chicago Sanitary District and is efficiently managed.

There are 11 plants serving a population of 24,100 involving two-story tanks followed by intermittent sand filters. So far as known these plants, with the exception of the one at Sandwich, are more or less neglected though some of them are designed on a sufficiently liberal basis to insure good results with good management. The Sandwich plant has always been well managed and produced a good effluent.

There is but one plant comprising two-story tanks and contact beds, namely, at Sparta (population 3,300). This type of installation was used in order to avoid pumping. It has not received systematic attention and has not given desired results. There are dwellings within a few hundred feet of this plant and there has been some complaint. There are some country club plants and plants for private institutions which comprise two-story tanks followed by subsurface disposal. One of these is installed at the Shore Acres Country Club.

At Great Lakes, the naval training station, there is a plant that is rather unique in the field of sewage disposal in that it comprises mechanical filters of the type commonly used in connection with the purification of public water supplies. These filters receive the effluent from two one-story sedimentation tanks operated in series. There are separate sludge-digestion tanks. The effluent from the sedimentation tank is passed through a secondary tank which was designed to serve as a coagulation and sedimentation basin. The use of alum and lime was soon abandoned but the basin has been continued in service as a secondary settling tank. The operation of this plant has not been entirely successful.

The year just past marks the initiation of sewage-treatment plants on a relatively large scale under the three sanitary district laws and they will be watched with interest to observe to what extent the sanitary district organization favors good operation and maintenance. At the annual meeting in 1922 there was a symposium on sanitary districts which brought out the point that the sanitary district laws were favorable to better results in sewage treatment than had hitherto been obtainable because these laws provide a means for raising reasonably adequate funds for building, maintaining and operating sewage-treatment works and intercepting sewers. Furthermore, these laws provide for an organization with the sole duty of properly carrying out these functions. Among engineers experienced in sewerage practice these attributes of sanitary districts will be appreciated, for it is well known that sewage disposal is the last thing that a municipality desires to spend money for unless it be the matter of maintaining and operating the works after they are built. Sewerage engineers are also aware of the pressure that is brought upon them to cut the cost of works, thus resulting in reducing the capacity of installation to a point where they can not function properly.

Following is a list of plants built and building under sanitary district organizations with notations covering their principal characteristics.

1. The Calumet plant of the Chicago Sanitary District comprises sedimentation tanks of the two-story type, sludge beds, about ¾ acre of sprinkling, and several units for activated sludge. The plant is built to serve 150,000 with an average flow of 37,000,000 gallons per day or about 250 gallons per capita. Average detention period in tanks, 2.9 hours. Gas-vent area, 17 per cent of total tank area. Total depth of tanks below water surface, 25 ft. Sludge-bed area 333 sq. ft. per 1,000 population with room for expansion in case this proves insufficient.

Aeration tanks capable of handling an average flow of 1,750,000 gallons per day with a 4-hour detention period allowing for 25 per cent of returned activated sludge. Activated-sludge tanks arranged in two units, one to receive fine screened sewage and the other to receive effluent from two-story tanks. Sedimentation tanks for activated sludge filled with Dorr thickeners and operating on a basis of 1,550 gallons per sq. ft. per day. Sprinkling filters to be operated at average population load of 9,400 per acre, equivalent to 2,350.000 gallons per acre with dosing apparatus to permit increasing these rates by 50 per cent. Filtering medium con-

sists of 5 ft. 10 in. of 2-in. broken stone underlaid by 6 to 12 in. of broken stone varying in size from 2 to 4 in. Secondary sedimentation basins following sprinkling filters are of the Dortmund type with average retention period of 1.5 hours.

2. The DesPlaines River activated-sludge plant is designed to care for a population of about 40,000 in a number of communities west of Chicago and along the DesPlaines River. It comprises an air-compressor plant, coarse rock screens, grit chambers, Reinsch-Wurl fine screen, four aeration tanks, settling tanks and provisions for de-watering sludge. Several types or designs of devices are used throughout and the plant is flexible in operation and fully provided with measuring devices so that it may be used as an experimental plant to yield data that may serve as a basis for the design for other plants to be built in the district.

The capacities of the various elements have been made liberal to allow latitude for experimental purposes. Assuming the nominal capacity at 4,000,000 gallons per 24 hours the various devices would operate at the following rates: Grit chambers, velocity 1 ft. per second operating singly, retention period about 40 seconds. Aeration tanks have a detention period of about 6 hours. Two depths of tanks, 10 and 15 ft., are provided and baffles are arranged to produce velocities of approximately 1.36 to 2.72 ft. per minute. Two of the tanks are arranged for re-aeration of sludge before being applied to the incoming sewage with means for adjusting the period of aeration. Sedimentation tanks have a detention period of about 2½ hours assuming an effective depth of 8 ft. Half of the tanks are provided with steep-sided pyramidal bottoms and half with Dorr thickener devices. There is one additional sedimentation tank with a Dorr thickener device for sedimentation of re-aerated sludge. The plant has not been in operation long enough (placed in operation December 1922) to afford any operating data of interest, though it is now turning out a uniformly satisfactory and nonputrescible effluent.

3. At Decatur there is under construction a sewage-treatment plant for handling mixed domestic sewage and sewage and wastes from a corn-products works in the proportion of one waste to 5.4 domestic sewage. This proportion will change from time to time with the growth of the city. The design provides for a tributary population of 60,000 estimated for about 1930 with a total dry-weather flow of mixed sewage of about 7,960,000 gallons per 24 hours. The plant comprises coarse screens, grit chambers, sedimentation tanks of the Imhoff type, sludge beds, sprinkling filters, and final sedi-

mentation tanks equipped with Dorr thickeners. The present installation will include but one-half the full equipment of filters and final sedimentation tanks. The nominal rates used in the several devices will be as follows:

Grit chambers will provide a velocity of 1 ft. per second for a flow length of 75 feet. Imhoff tanks will provide a displacement of 2.05 hours at the start of operation and of 1.51 hours at the time of enlargement. The sludge-storage capacity will be 3.88 cubic feet per capita at the start of operation and 2.97 cubic feet per capita at the time of enlargement. Sludge beds will have an area of 667 ft. per 1,000 population with provisions for extension to 1,000 sq. ft. per 1,000 population. Sprinkling filters will have a population load of 10.000 per acre when the entire installation is completed and a population load of 15,300 per acre based on the present population. These rates represent 1,330,000 gallons and 1,950.000 gallons per acre per 24 hours, respectively. Final sedimentation tanks are designed on the basis of 3,000 gallons of sewage per sq. ft. of total tank surface for 24 hours, equivalent to an approximate total displacement perio dof 30 minutes.

4. The North Shore Sanitary District comprising the cities and villages along the shore of Lake Michigan in Lake County is now building 5 small treatment plants. The effluent from 3 of these will be discharged into Lake Michigan and the treatment will involve sedimentation in tanks of the Imhoff type and sterilization of the tank effluent with liquid chlorine to protect bathing beaches. The effluents from the other 2 plants will be discharged into Skokie Ditch and the treatment will involve sedimentation in tanks of the Imhoff type, filtration through sprinkling filters and final sedimentation in tanks of the Dortmund type. In these plants the following approximate rates and loadings have been adopted: Imhoff tanks. displacement period 4.0 hours; sludge storage capacity 3.0 cubic feet per capita. Sludge beds, 1,000 sq. ft. per 1,000 population. Sprinkling filters. 2,500,000 gallons per acre per day and a population load of 12,500 per acre. Final sedimentation basins, 1,500 gallons per sq. ft. of tank surface per 24 hours.

5. The Downers Grove Sanitary District treatment plant is assumed to handle the sewage from a population of 4,000 producing 100 gallons of sewage per capita. On this basis the several parts would have the following rates and loadings: Imhoff tanks, detention period of 2.6 hours and sludge storage of 2.4 cubic feet per capita. Sludge beds, 625 sq. ft. per 1,000 population. Sprinkling filters, 15.000 population load per

acre of 8 ft. deep. Final sedimentation, detention period 2.6 hours.

6. For the Urbana-Champaign Sanitary District, designs are being prepared for sewage-treatment works. After an extensive investigation of activated sludge and careful comparative studies of relative economies of various treatments, a decision was reached in favor of Imhoff tanks, sprinkling filters and final sedimentation.

By way of general summary we may say that sewage treatment in Illinois has not hitherto been very successful because of inadequate financing ability and apathy on the part of municipalities. Under the several sanitary district laws sewage treatment appears to be placed on a good basis with reference to financing, design and construction, and operation. It remains to be seen how well the continued operation of such plants is carried out and also the actual cost of operation. Many cities may well afford to install necessary sewage-treatment plants and to better operate those already installed. In some instances, the conditions may be favorable to the formation of additional sanitary districts.

TABLE 1. SEWAGE-TREATMENT PLANTS IN ILLINOIS

January 1923

(This list probably is not complete.)

Sewers: S—sanitary; C—combined; M—mixed sanitary and combined; St—storm.

SEWAGE-TREATMENT PLANTS

T—Tank, plain settling, septic seondary settling
I—Imhoff tank
D—Separate sludge digestion tank
S—Sand filters
P—Percolating and sprinkling filters
C—Contact beds
R—Roughing filter
A—Activated sludge
B—Sludge drying bed
Cl—Chlorine

PLACE	Pop. 1920	Sewer System	Type	Year installed (Sewage-treatment plants)	Date last inspection	Condition and remarks
Aledo	2,331	S	TP	1909	6-19	Unsatisfactory Overloaded?
Anna	3,019	S	T	1912–1923	7-22	O.K.
Antioch	775	S	ISB	1921	10-21	O.K.
Arlington Heights	2,250	C	TS	1912	4-20	Neglected
Ashton	882	S	TS	1917	10-19	Neglected
Atlanta	1,173	S	T	Prior 1913	5-21	Neglected
Barrington	1,743	C	IS	Prior 1912	7-14	O.K.
Belleville	28,823	C	T	Prior 1914	7-15	Overloaded
Benton	7,201	M	T	1914	2-21	T abandoned
Bushnell	2,716	S	IP	Prior 1914	9-21	P abandoned
†Calumet Region	150,000	C	IBAPT	1922	1-23	O.K.
Cambridge	1,335	S	ISB	1918	9-21	Neglected

Canton	10,928	M	T	1910	9-14	O.K.
Carrollton	2,020	S	T	1914	4-15	O.K.
Carthage	2,129	S	T	1911	9-19	Overloaded
Cary	463	S	I	1922	1-22	O.K.
Centralia	12,491	S	T (part)	1904	11-14	O.K.
Champaign	15,873	S	T	1894	6-14	Tank abandoned
Chicago Heights	19,653	S	IPB	1921	1-21	O.K.
Christopher	3,830	S	T	1916	8-21	Neglected
Collinsville	9,753	S	T	1907	10-16	Neglected
Crystal Lake	2,249	S	TDS	1910		
Cuba	1,484	S	I	1921	8-21	O.K.
DeKalb	7,871	S	T	1916	12-17	O.K.
				1914–1915	9-21	Neglected
			TPB			Overloaded
Depue	2,552	C	T	1914–1915	9-21	O.K.
DesPlaines River	30,000	C	A	1920	9-15	O.K.
Downers Grove	3,543	S	IPTB	1922	1-23	O.K.
Duquoin	7,285	S	T	1922	10-20	O.K.
Earlville	1,012	M	IPB	1907	6-19	Neglected
Edwardsville	5,336	C	T (part)	1921	12-21	O.K.
Eldorado	5,004	S	T	Prior 1914	8-21	Tank abandoned
Elmhurst	4,594	C	ISB	1922	1-22	O.K.
Fairfield	2,754	S	TR	1919	9-19	O.K.
Farmington	2,631	S	IS	1914	none	?
Flora	3,558	S	T	1921	1-22	O.K.
Galva	2,974	S	IPB	1917	7-17	Neglected
				1911	10-20	Overloaded
Geneseo	3,375	C	T			Neglected
Geneva	2,803	S	I	1922	7-20	O.K.
Genoa	1,228	S	I	1914	6-21	O.K.
Georgetown	3,061	C	T	1915	6-15	O.K.
Glencoe	3,381	S	TP	1918	10-18	O.K.
Glen Ellyn	2,851	M	TP	1903	3-12	P abandoned
Grays Lake	736	S	I	1913	9-19	Neglected
Greenville	3,091	S	TS	1907	9-19	Neglected
Harvard	3,294	S	TS	1915	12-19	Neglected
Herrin	10,986	S	T	1908	1-21	O.K.
Highland Park	6,167	S	TIP	Prior 1912	12-12	Neglected
Highwood	1,446	S	IBPT	Prior 1912	2-15	Neglected
Hillsboro	5,074	S	T	1923		Under construct'n
Hoopeston	5,451	S	T	1916	none	?
Jerseyville	3,839	S	T (part)	1910–1911	10-19	Overloaded
Johnson City	7,137	S	IPTB	Prior 1914	6-11	Tank abandoned
Kewanee	16,026	S	T	1922	none	Under construct'n
LaGrange	6,525	C	TP	Prior 1913	10-19	O.K.
Lake Bluff	819	S	IBCI	1910	4-20	O.K.
Lake Forest	3,657	C	IB	1923		Under construct'n
Lake Zurich	316	S	T	Prior '13–'23	6-13	O.K.
Lewistown	2,279	S	T	1916		?
Libertyville	2,125	S	T	1912	12-20	Neglected
Lombard	1,331	C	IDS	Prior 1912	8-21	O.K.
McLeansboro	1,927	S	T	1918	9-19	O.K.
Macomb	6,714	S	T	1907	9-21	O.K.
Manteno	1,882	C	T	1894	7-14	O.K.
Marion	9,582	S	TB	1911	8-19	O.K.
Mendota	3,934	S	IS	1914	1-22	Tank abandoned
Moline	30,734	S		1921	12-21	O.K.
	5,000		ICI	1913	3-20	O.K. if Cl

Momence	2,218	C	T (part)	Prior 1910	9-10	O.K.
Monmouth	8,116	C	T	Prior 1912	8-12	O.K.
Morton Grove	1,079	S?	IPB	1914	2-17	Chicago Sanitary District, O.K.
Mounds	2,661	S	TP	1914	8-15	Neglected
Mt. Vernon	9,815	M	T (part)	1910	11-20	Tank abandoned
Naperville	3,830	S	T	1905	8-15	O.K.
Neoga	1,149	S	T	1920	2-20	O.K.
Nokomis	3,465	S	IB	1920	9-20	O.K.
North Chicago	5,839	S	TP	1913	1-17	Neglected
Oblong	1,547	C	T	1910–1922	1-23	O.K.
Olney	4,491	S	ISB	1914	2-21	O.K.
Palatine	1,210	C	I	1914	4-20	Neglected
Palestine	1,803	S	IS	1918	2-21	O.K.
Pana	6,122	S	IPTB	1915	1-22	Overloaded and neglected
Paris	7,985	S	T	1899	2-22	Neglected
Pinckneyville	2,649	S	T	1919	6-19	O.K.
Plano	1,473	S	T	1914	11-14	O.K.
Polo	1,867	S	TC	1906	8-19	C abandoned
Pontiac	6,664	C	I	1921	1-22	O.K.
Princeton	4,126	S	TP	1900–1911	11-14	Neglected
Rankin	994	C	T	1915	5-20	O.K.
Robinson	3,375	S	T	1906	7-14	O.K.
Rochelle	3,310	S	T	1907	6-19	Overloaded
St. Charles	4,099	S	I	1917	1-22	?
Salem	3,457	S	IB	1916	6-19	O.K.
Sandwich	2,409	S	ISB	?	2-21	Overloaded
Sparta	3,340	S	ICB	1917	1-22	O.K.
Toluca	2,503	C	T	1909	5-13	O.K.
Urbana	10,244	S	T	1894	10-15	To be abandened
Villa Park	854	C	I (part)	1917	5-21	O.K.
West Chicago	2,594	S	TS	1918	9-21	O.K.
Wheaton	4,137	S	T (part)	1904	8-18	Overloaded
White Hall	2,954	S	T	1913	9-13	O.K.
Woodstock	5,523	S	TS	1908	5-22	Overloaded
Wyoming	1,376	C	T	1907	2-15	Overloaded Neglected

†Chicago Sanitary District.

Federal Institutions						
Fort Sheridan	?	S	TPB	1912	4-12	O.K.
Great Lakes	?	S	TDTSP	1917	2-21	Neglected
Belleville Scott Aviation Field	?	S	IATB	1917	7-18	Overloaded
State Institutions						
Alton State Hospital	729	S	TP	1917	2-22	O.K.
Dixon Epileptic Colony	345	S	IPB	1918	5-18	O.K.
St. Charles School for Boys	813	S	IP	1917	9-19	O.K.
County Institutions						
Adams Co. T.B. Sanatorium		S	TP	1920	2-22	O.K.
Kane Co. T.B. Sanatorium		S	T	?	10-20	O.K.
Mason Co. Almshouse		S	TS	1911	7-13	O.K.
McLean Co. T.B. Sanatorium		S	TSB	1919	11-21	O.K.
Peoria Co. Poor Farm	150–250	S	T	?	3-18	O.K.
Sangamon Co. Poor Farm	130–225	S	TR	?	2-13	?
Tazewell Co. T.B. Sanatorium		S	T	?	7-20	?

Private Institutions						
Arch-Diocesan Seminary, Area	250	S	IPTCI	1921		O.K.
Flossmoor Country Club	150–200	S	T	1919	8-20	O.K.
Geneseo Outing Club		S	T	?	6-22	O.K.
German Evangelical Orphans & Old Peoples Home, Bensonville	120	S	T	?	5-21	Neglected
Idlewild Country Club, Flossmoor	75	S	T	1919	8-20	O.K.
Kenilworth Sanatorium, Glenview		S	T	?	9-21	Neglected
Northmoor Country Club, Highland Park		S	T	1921	9-22	Neglected
Olympia Fields Country Club	200–1000	S	I	1919	9-22	Neglected
Shore Acre Country Club, Lake Bluff		S	I	1920	9-22	O.K.

TABLE 2. SEWAGE-TREATMENT PLANTS IN ILLINOIS

SINGLE-STORY TANK ONLY

(No distinction between plain settling and septic)

Anna
Atlanta
Belleville (3 tanks)
Bensonville Orph. Home
Benton
Canton
Carrollton
Carthage
Centralia
Champaign
Christopher
Collinsville (2 tanks)
DeKalb
Depue
Duquoin
Edwardsville (part of city)
Eldorado
Fairfield
Flora
Flossmoor Country Club
Geneseo
Geneseo Outing Club
Georgetown
Highland Park (3 tanks)
Hillsboro
Hoopeston
Idlewild Country Club
Jerseyville (part of city
Kane Co. T.B. Hospital
Kenilworth Sanitarium
Kewanee
Lake Zurich
Lewistown
Libertyville
McLeansboro
Macomb
Manteno
Marion
Momence (part of city)
Monmouth
Mt. Vernon
Naperville
Oblong
Paris
Peoria County Poor Farm
Plano
Polo (contact beds abandoned)
Robinson
Rankin
Rochelle
Tazewell County T.B Hospital
Toluca
Urbana
Wheaton
Whitehall
Wyoming
Neoga

SINGLE-STORY TANK AND SPRINKLING OR PERCOLATING FILTER

Aledo
DeKalb
Fort Sheridan
Glen Ellyn
Highland Park
La Grange
Mounds
North Chicago
Princeton
Alton State Hospital
Adams Co. T.B. Sanatorium

SINGLE-STORY TANK AND INTERRMITTENT SAND FILTERS

Arlington Heights
Ashton
Flossmore
Greenville
Harvard
Lombard
West Chicago
Woodstock
Mason Co. Almshouse
McLean Co. T.B. San.

SINGLE-STORY TANKS AND SUB-SURFACE DISPOSAL

Arden Shore Resort
Calumet Country Club
Northmoor Country Club
Idlewild Country Club

TWO-STORY TANK ONLY

Cary
Cuba
Geneva
Genoa
Grays Lake
Lake Forest
Nokomis
Palatine
St. Charles
Salem
Pontiac
Villa Park (part of city)

TWO-STORY TANK AND CHLORINATION

Highland Park (part of city)
Lake Bluff
Moline (part of city)

TWO-STORY TANK AND PERCOLATING OR SPRINKLING FILTER

Bushnell
Calumet Region
Chicago Heights
Decatur
Downers Grove
Earlville
Galva
Highland Park (part of city)
Highwood
Johnston City
Morton Grove
Pana
Dixon Epileptic Colony
St. Charles School for Boys
Arch-Diocesan Seminary

TWO-STORY TANK AND INTERMITTENT SAND FILTERS

Antioch
Barrington
Cambridge
Elmhurst
Farmington
Flossmore Country Club
Mendota
Olney
Sandwich
Palestine
Olympia Fields Country Club

TWO-STORY TANK AND CONTACT BED

Sparta

TWO-STORY TANK AND SUB-SURFACE DISPOSAL

Shore Acres Country Club

ACTIVATED SLUDGE

Calumet Region (experimental units)
Des Plaines River Plant (Chicago Sanitary District)
Scott Aviation Field, Belleville

SEDIMENTATION AND MECHANICAL FILTER

Great Lakes Naval Training Station

REPORT OF THE COMMITTEE ON DRAINAGE LEGISLATION

Your Cmmittee on Drainage Legislation has examined the proposed revision of the levee act as embodied in Bulletin 42 of the State Geological Survey. Your Committee finds that this suggested revision does not materially change the existing law. Your Committee finds that all the court decisions and precedents which are of essential value in interpreting any drainage law will still be applicable to the proposed revision. The revised law does, however, rearrange the various acts in a more workable form, provides a more logical sequence and eliminates some of the conflicting paragraphs in the present form of drainage laws. Your committee recommends the endorsement of this revised levee act by the Illinois Society of Engineers and further recommends that a copy of said ndorsement be transmitted to the chairman of the committtee on drainage of the Ilinois State Legislature.

Your Committtee further presents herewith a proposed act providing for the preliminary expenses involved in the organization of a drainage district. This proposed act was submitted by a member, Mr. T. N. Jacob. It is patterned after a similar act embodied in the drainage laws of Missouri. Your Committee recommends the approval of this act by the Illinois Society and that a copy of such approval and endorsement be also sent to the chairman of the Committee on Drainage Legislation of the Illinois General Assembly.

L. K. SHERMAN *(Chairman)*, C. E. DELEUW, G. W. PICKELS.

That Chapter 42, "R. S. DRAINS, DITCHES AND LEVEES FOR AGRICULTURAL, SANITARY AND MINING PURPOSES;" An Act to provide for the construction, reparation and protection of drains, ditches and levees, across the lands of others, for agricultural, sanitary and mining purposes, and to provide for the organization of drainage districts (Approved and in force May 29, 1879. L. 1879, p. 120. (1)" be amended by adding as eighth paragraph to Section 9 the following:

Levy of Tax to Pay Cost of Organization.—The commissioners of any drainage district organized under the provision of this act shall as soon as appointed and qualified, levy a uniform tax of not more than fifty cents per acre upon each acre of land within such district, as defined by the petition, to be used for the purpose of paying expenses incurred or to be incurred in organizing said district, making surveys of the same and assessing the benefits and damages and to pay other expenses necessary to be incurred before said board shall be empowered by subsequent provisions of this act to provide funds to pay the total cost of works and improvements of the district. In case the boundary lines of the district be extended under the provisions of a subsequent section of this act, so as to include lands and other property not described and contained in the petition, the same uniform tax shall be made on such lands and other property as soon as same shall have been annexed and included in the district. Such tax shall be due and payable as soon as assessed and if not paid by December of the year in which it has been levied, the same shall become delinquent. It shall

become a lien on the land and other property against which it is assessed and shall be collected in the same manner as the annual installment of tax. In case the sum received from such assesement exceeds the total cost of items for which the same has been levied, the surplus shall be placed in the general fund of the district and used to pay cost of construction: Provided, that if the corporation of the district be dissolved, as provided for in a subsequent section of this act, the amount of surplus, if there be any, shall be prorated and refunded to the landowners paying such uniform tax.

LAND DRAINAGE DEVELOPMENT IN FREEBORN COUNTY, MINNESOTA

BY J. W. DAPPERT

Freeborn and Mower counties, where my activities have mostly been centered, lie upon the south boundary of the state, in latitude 43° 40′, or only 90 miles farther north than Chicago. The climate is not much different from northern Illinois, and the soil and crops grown are similar. It is in the corn belt and the land produces quite good crops of corn and other cereals, the same as contiguous portions of Iowa. The soil is a sandy clay and silt loam, rich in elements of fertility and quite deep. The surface topography is typical of most glaciated areas.

It is probable that the last great ice invasion to which the present topography here is indebted, took place but 2000 or 3000 years ago, and that the ice was from 600 to 1200 feet thick, during even the latest epoch of its invasion. At a few places it became piled up to even greater depths, and the greater weight of ice scooped deeper into the soft earth where heaviest, and upon the recession of the ice-sheet in melting, the thicker ice-masses remained longer and melted last, thus forming the large number of small lakes dotting all this country. The glacial boulders found along the course of Turtle Creek, to east and south-east from this marsh area, with striae still well defined, prove the correctness of the theory of glacial activity in the past. Lake Geneva, west of the marsh under consideration, shows plainly the effect of the thicker mass of ice there accumulated, which upon melting left a lake of water. Like many of the glacial lakes, it has two lobes, probably having been thus made by a halt and forward movement after its recession had begun, due to a few years or a few hundred years of increased cold after the climate had begun to get warmer.

After melting away of most of the marsh, the marsh area began to form. Water was present everywhere, especially as the snow melted in the warm spring days, and all these marsh lands were covered half the year with water. Sphag-

num moss, rushes and other shallow-water grasses and flags and such vegetation as thrives by water grew in abundance, and by decaying year after year for two thousand years or more, has built up a soil which is as fertile as any upon earth. In a few places the live sphagnums are still to be seen as proof of the work done. The east shore of Lake Geneva has been formed by ice action of later years, and the process is still going on. As ice expands from five to fifteen per cent as the water congeals, the expansion pushes the ice shoreward, and where shallow, the ice freezes fast to the bottom of the lake, and at each freeze carries some of the clinging debris shoreward. That doubtless accounts for the lower east shore along this lake. True, this action wuld not be great in one single season, but multiply its effect by 2000 or more and such movement becomes quite pronounced I have seen upon this lake a shoreward movement of fifteen feet caused by ice expansion in a single heavy freeze. Always the lake was deeper upon its central axis than elsewhere, and no doubt that originally Geneva Lake extended eastward and covered all the marsh, until its shore barrier was thus formed.

The natural drainage of this marsh area was well started by the gradual deepening and widening of Turtle Creek, when the surrounding country was first settled. About 1870 the Southern Minnesota Ry. acquired title to a large part of this marsh, and soon after a dam was thrown across Turtle Creek at Moscow, and a water-mill installed for the grinding of flour. This dam was ten or twelve feet high, and held the water back npon the greater part of the marsh and greatly impeded the further natural erosion of a channel.

The old mill dam was removed after the lands were acquired by P. M. McMillan about 25 years ago. Later about three-fourths of the McMillan holdings were sold to Barber Brothers of Polo, Ill., and their interests acquired by the Albert Lea Farms Co. in 1918.

This land development company is headed by Mr. G. H. Payne, who is also president of the Payne Investment Co. of Omaha; and Col. Stroud is also one of the large investors in this project. Both of these gentlemen came originally from Illinois. Upon acquiring these lands, the first thing done by the Albert Lea Farms Co. was to secure engineering advice, and R. N. Towl, consulting engineer, of Omaha, Mr. Severson, of Albert Lea, and myself were called into consultation, and have been retained in an advisory or other capacity since the inception of the project. Later the writer was made chief engineer, and his son, Merlin L. Dappert, principal assistant in active charge of the construction. We have two other assistant engineers, Harry Kluss, graduate of Ames, in charge

of field surveys, and Harold Engstrom, graduate of Nebraska U., in charge of soil surveys nad farm construction. Also from six to ten other helpers are employed, usually students from various universities, which personnel changes frequently.

Complete topographic surveys are made by means of the Y-level and transit, and maps of the various units with 1 foot contours are prepared, also soil survey maps showing character and location of the predominant types of soil, all rather minutely. When tile drains are installed, a map and prints of each farm unit are made, usually upon a scale of 200 feet per inch, and the final purchaser of the tract given a print thereof. It is found that the character of soil, and especially the sub-soil, changes frequently quite abruptly, at depths of from 3 to .... feet, hence borings are made at frequent intervals, and soil analyses made from the samples and recorded. The three soils of the lower strata are fine sand, silt and clay, and top surface, from two to six feet in depth mostly decomposed peat.

Other investigations made in the soil survey relate to porosity, capillarity, rainfall, runoff, seepage, climatology and similar subjects, all related to questions of drainage, and are determined in advance of the tile drainage of the lands. Temperature and moisture readings are taken and recorded daily. Also, a large number of test wells are maintained in the tile-drained areas, whose surface elevatins are closely determined, from which the depth of the ground-water plane and its movements are observed and recorded daily, or at longer intervals when weather conditions are steady.

The higher uplands surrounding this marsh area are from 20 to 70 ft. higher than the marsh land. The flat area has a fall eastward of 4 ft. per mile for the first three miles from Lake Geneva, then flattens to practically level for the next ten miles. Rice Lake, originally a meandered lake, and segregated from the public domain, contains 1565 acres, and is from two to three feet lower than adjacent marsh lands. The northeasterly portion of the marsh, along Deer Creek, is from two to four feet higher than the main marsh, and the same is true of the southeasterly portion, but along Mud Creek, north central part of the marsh, the elevations are near the same as at its point of discharge into the main ditch. No complete topographic map was made of the whole marsh, due in the first place to the fact that the law made no provision by which the expense of same could be met, but the elevations were taken pretty well over the entire area and a rather thorough reconnoiter made by which the wet areas and marsh lands were mapped, showing limits of high lands, improvements and other cultural features.

The ditches were located upon straight lines and on section or legal subdivisional lines or parallels as much as possible, but down the old Turtle Creek valley which is but from 300 to 1000 feet wide, with contiguous bluffs from 40 to 90 feet high, it was not feasible to keep long on straight lines. Rice Lake being the controlling feature in the design, being the lowest, relatively, part of the area to be drained, the main ditch was designed of sufficient depth and size to reach it with a freeboard of 2 ft. in extreme floods, and of 5 ft. in normal floods, above the hydraulic grade line. This required constructing a main ditch 50 ft. wide at base for the lower 9300 ft., then 44 ft., and reducing in width at each junction of principal lateral, first to 34 ft. after passing Deer Creek, and so on to a width of 8 ft. at its upper terminus, with all side slopes 45°. The lower 8 miles of the main ditch and most of the Rice Lake lateral has a sub-grade starting level with the grade and keeping level for 20,000 ft. until the side grade becomes two feet higher than center, then parallels it, with apex of V at center of the ditch, continuing thus with a gradient of 0.01 ft. per 100 ft. for eight miles, to junction of Rice Iake lateral, and continuing thus for two miles up said lateral. Some of the smaller laterals and upper portion of the main have gradients ranging from .04 to .10 per 100 ft.

The maximum cuts below natural surface are slightly over 21.5 ft., and the general average is 12.5 ft. The main ditch for 8 miles has an average depth of 16 ft., and the whole excavation upon the clean-out now going on amounts to 1,250,320 cubic yards. More than 1,7500,000 yards were removed in the original construction of this system of ditches in 1907–10. Considerable information as to rate of siltage has been obtained in this reconstruction work. In 12 years since its original construction, the ditches had silted up about 2.4 ft. on the average. The lower portion of the main ditch was found to have become filled less where it contained a more constant volume of water, even though its grade was but 0.01 per 100 ft., while the smaller laterals whose gradients were as much as .10 per had become filled as much as 3 ft. or more in places. The filling was due mostly to the surface waters washing over the banks, where natural streams entered. These have now all been cared for by the construction of culverts, inlets, catch-basins and like structures, using reinforced concrete headers at outfall and at intake ends, all of a fairly permanent character, and at an expense of $35.000. We hope by this method to prolong the life of this ditch many years. In the original ditch, after construction, there was no patrol or repairs whatever for the 12 years of its life, and

many willows and cottonwoods to the diameter of a foot or more had grown along and within its banks.

About $30,000 worth of bridge repairs and replacement, and $33,000 worth of drain tile construction, and a total of $256,000 worth of materials and work comprise all the drainage district improvements now under way and about three-fifths completed. The area of marsh lands tributary and assessed for this improvement is 20,500 acres, and average rate of assessments is near $16 per acre, including engineering and other legal expenses of administration.

The whole water-shed area draining to the main ditch at Moscow is 88,183 acres, and at outlet 95,037 acres. The ditches were designed to convey, without overflow, and with from 2 to 5 ft. freeboard, $3/8$-in. runoff per 24 hours from the entire water-shed for the main ditch, and $1/2$-in. for the laterals. Most of the laterals are over-capacity but it was not feasible to construct and maintain them with a narrower base. In the calculation of velocities and capacities, Kutter's formula was used, making $n=0.0225$ upon the main, 0.025 upon the larger laterals, and up to $n=0.035$ upon the smaller laterals. In May, 1921, the measured flow of water in the main ditch, before reconstruction, a short distance above the junction of Deer Creek, was 264 second-feet, after a rainfall of 7.38 inches in 20 days. This measured runoff came from a water-shed area of 62,060 acres.

About half the water-shed area is rolling, slightly hilly, and its runoff is fairly rapid. Upn the flat marsh areas covered with a peaty soil that absorbs half its volume of water, the runoff is very slow. Lake Geneva, to the west, further acts as a storage basin, in floods, to slow up the runoff. This is a meandered lake, segregated from the public domain, comprising an area of 1262 acres, and at its outlet we have constructed a combined culvert-dam and spillway, carying a new road, and thic culvert and spillway are designed to control the outflow from the lake, and turn the surplus water into the head of the main ditch which comes up to within 50 feet of the margin of the lake. This structure was designed by R. W. Towl, consulting engineer.

It consists of a square reinforced concrete box, 6x6 ft., inside dimensions, with a circular intake or well 20 ft. in diameter upon the lake-side end, and wing walls at ditch end, with heavy pile foundation, and a row of piles to serve as ice-breakers, driven 10 ft. outside the outer periphery of the well or bowl, the top of which bowl is battered toward the culvert, so as to take low-water flow at lower edge, and as water rises in the lake, admit the full capacity of the box. Its

intake end is provided with a concrete flash-board 6 ft. long and one foot high, designed to be raised upon approach of heavy rainstorms, thereby providing for an extra foot of storage space in the lake, and replaced upon the water reaching the stage where it would fill or overflow the box culvert. It thus provided an added storage amounting to ¾-in. runoff from the water-shed of 19.720 acres. Observations of rainfall for 40 years show this will be a safe allowance, the capacity of the culvert being 210 second-feet, while the probable runoff from the lake is not likely to ever exceed 185 second-feet. The level of the lake with flash-board in place is 15.5 ft. above the grade of the outgoing ditch, and the observed seepage was 0.5 second-feet when fill was new. As to the possibilities of irrigation of crops during the dry seasons, the lake level is from one to twelve feet higher than 95 per cent of this 15,000 acre tract.

In the work of development being done by the Albert Lea Farms Co. good graveled roads are constructed at intervals of every mile upon the marsh area and leading away therefrom, about 40 miles of which have been now completed, connecting with other state and county roads, making the tract easy of access from all directions, and with as good roads as can be found in the state. Often the gravel had to be hauled a mile or two from the glacial ridges at margins of the marsh, and in the more peaty soils, clay and sand had to be also hauled in to provide a foundation upon which to place the gravel. Road-side ditches built by means of a large Buckeye tractor ditcher provided some of the road material. After the roads were graded and graveled, large tiles were laid in these ditches, and earth from the edges pushed in by road-graders, covering the tiles approximately 3 feet, leaving a broad, shallow ditch at road sides, which can be readily crossed with vehicles, and are sown to clover and timothy and mowed for hay.

All the lower portions of the marsh are being tiled, the drains being laid out on the gridiron system, mainly at intervals of from 80 to 160 and spaced as far as 320 feet apart, depending upon character of soils encountered. Five-inch tiles are the smallest size being used, and 24 inches the largest. Both clay and cement or concrete tiles are being used, whichever variety can be most easily obtained. Some chemical analyses of sub-soil have been made, and it was thus determined that no sufficient injurious salts exist here to leach out the lime of cement pipes or endanger their structure. Freezing and thawing, where tiles were quite shallow, has destroyed a half-mile or so of the red clay tiles, and these were replaced with cement tile.

Slightly over 200 miles of tile drains have been installed in these lands, the trenching being mostly done by hand labor. After tiles are tested by levels taken at intervals upon them, loose, fine earth is placed over them a foot or so in depth, and then the ditches are refilled with a road-grader drawn by a tractor, about 20 of which are in use upon the farms, and all left in as smooth and nice condition as possible.

These lands when drained and cropped for one or two seasons are being sold to the "Holland Dutch" in tracts of from 40 to 160 acres each, some of the purchasers having but recently come from Holland. About 2000 acres have been thus far disposed of by sale, and many new buildings of a good character have been erected, there being certain restrictions as to the kind of buildings which may be erected, so as to insure a high grade of structures. A new city called Hollandale has been laid out, and several new buildings erected, including a church and school. Plans are under way for a new hotel, bank, garage, general mercantile store and 20 new cottages. A new school costing $5000 is under construction, temporary church completed, which will become a parsonage upon completion of the new church, and another new school planned for erection this year, with also a community club house.

The large crops of grain and sugar beets raised upon these farms the past year and the larger area to be under cultivation next season demand closer railroad facilities, the haul by wagon or truck being from 7 to 12 miles, and to meet this need plans are under way to construct a branch line from near Ellendale, southeast ten miles into the center of this marsh. Preliminary surveys are being made for this branch railroad. Two carloads of celery were raised the past season upon less than ten acres of muck land and brought fancy prices in the city markets. This experiment promises that more than 3000 acres of these muck lands are particularly adapted to the raising of celery and the acreage in celery will be very greatly increased next season.

DRAINAGE CONDITIONS IN THE SOUTHERN MISSISSIPPI VALLEY STATES

BY JACOB A. HARMAN

The wet lands of the lower Mississippi Valley are principally in four states: Missouri, Arkansas, Louisiana and Mississippi, extending from Cape Girardeau, Mo., to the Gulf of Mexico. The total area of these wet lands is estimated at 20,000,000 acres, most of which was subject to overflow from the Mississippi river and tributaries. The levees being

completed along the Mississippi river under the direction of the Mississippi River Commission, in cooperation with the local levee districts, now give substantial protection from overflow to the major portion of the area of these lands and when completed will give effective protection to practically the entire area. The construction of levees in a small way in isolated localities began before the Civil War, but has been making definite progress since the organization of the Mississippi River Commission about 40 years ago. The work necessary to complete the levees along the Mississippi river and on the tributaries as far up-stream as the back-water from the Mississippi river affects the overflow is variously estimated to cost from $50,000,000 to $75,000.000, and a bill is now being considered by Congress which provides for the continuation of the Flood Control Bill, authorizing an expenditure of $100,000,000 by the Federal Government on improvement of the channel and protection of the banks of the Mississippi river, and for the construction of levees along the Mississippi river and tributary streams within the back-water influence of the Mississippi river. This proposed legislation will require that the levee districts, or land owners interested, shall contribute at least one-third of the cost of the construction of any levees built with Government aid under the Mississippi River Commission, and is similar in most respects, except as to the amount to be expended, to the Flood Control Act under which the Mississippi River Commission has been operating for the last six years.

The foregoing general statement of the flood control and levee protection is of special interest, because the major portion of all drainage in these southern states applies to lands which are subject to overflow by the Mississippi river and tributaries within the reach of the influence of back-water, so without the levee system extensive drainage works would generally be unjustifiable. These overflow lands represent only a small part of the entire area of thes states, but are the richest lands in the entire South, and equal in fertility to the most famous lands of the world, so that the demand for reclaimed lands in the cotton growing country has been especially great since there has been practical assurance of the successful maintenance of the Mississippi river levee system.

In 1850 the Federal Government by a General Act ceded the swamp and overflowed lands in the Mississippi Valley states to the several states to be reclaimed, and in many instances the states shortly thereafter ceded the lands to each of the respective counties. The proceeds from the sale of the lands to individuals was to be used for drainage purposes. In some cases this was done, but in all cases the funds ob-

tained from the sale of the lands failed to furnish an adequate system of protection and drainage, and the levees and ditches which have been constructed have been paid for in most part by general appropriations from the Federal Government expended under the Mississippi River Commission. The theory upon which the Federal Government has made appropriations for levee construction is that the building of levees is an aid to navigation, maintaining and stabilizing the channel of the Mississippi river.

In the Flood Control Bill, which was enacted in 1917, the principle of general welfare, as applied to flood control, seems to have been partially recognized. In 1606 to 1910 the drainage investigations of the Department of Agriculture, under the directorship of Mr. C. G. Elliott, of Washington, D.C., made extensive investigations, surveys and preliminary plans for the main drainage features of large areas of these lands in Missouri, Arkansas, Louisiana and Mississippi. The general interest in agricultural development and expansion in these years directed the active cooperation of land owners in those states and brought about the adoption of new and more effective laws for the establishment and maintenance of drainage enterprises, so that we find that the laws under which practically all drainage work in these southern states is now actively proceeding, are of comparatively recent origin. The present active drainage laws were enacted in Missouri, Arkansas and Tennessee in 1910 and in Mississippi and Kentucky in 1912, and practically all of the drainage work in these states has been accomplished since the enactment of these laws. Now nearly all the work has been completed in districts which have been organized, and in many of the organized districts the work has been found to be of a temporary nature and needs enlargement and reconstruction, so that a review of the area which is organized in drainage districts is not indicative of the extent of effective drainage work. A great deal of the work is now effective, and where the lands have been cleared and put into cultivation the agricultural returns thoroughly justify the expenditures.

The organizing and financing of drainage districts in these states are based upon the same general fundamental principles, and largely upon the same details of practice followed in the northern states for many years before the work became active in the South. Louisiana is a rather notable exception in which the Police Juries may organize either the entire parish, or any portion thereof into a drainage district, or drainage districts, and levy an ad valorem tax for the purpose of constructing and maintaining drainage works

under the police powers of the state. (In the State of Louisiana the sub-divisions corresponding to counties are called parishes, and the executive officers corresponding to commissioners, supervisors or county courts in charge of the administration of the business of the parish are called a Police Jury.) The drainage laws enacted in 1910 provide for the organization of drainage districts by Police Juries upon the petition of land owners and the appointment of commissioners by the land owners to administer the affairs of the districts organized upon petition.

A distinction is made between gravity drainage and drainage by pumping. Taxes are to be levied under a law enacted in 1920 for pumping districts on the basis of the benefits to the lands, and the amount of taxes is limited only by the amount of the benefits as determined upon the hearing; on gravity districts taxation may be by two methods: (1) ad valorem on the assessed value of the land, and (2) a flat acreage tax of an equal amount on each acre, but not exceeding a tax of 50c per acre in any one year. Bonds may be issued for pumping districts, based upon the cost and not exceeding the benefits in substantially the same manner as in other states. For the gravity districts, bonds may be issued against the acreage tax or against the ad valorem tax, or both; bonds may be issued for a period not to exceed 40 years, and the amounts to be issued against the acreage tax shall not exceed that which can be retired (principal and interest) by a tax of 50c per acre per annum, and for the ad valorem tax the bond issue shall not exceed 10 per cent of the assesed valuation of the real property in the district.

Bond issues can only be assessed by the favorable vote of a majority of the owners of land residing within the district who can own a majority of the land represented in such elections; the owner of land who is not a resident of the district has no vote upon the authorization of bond issues. These limitations upon the organization and financing of drainage districts in Louisiana have retarded and will continue to prevent the carrying out of much drainage work in that State until the principle of majority control and benefit assessment, without limitation on the annual tax levy, except as applied to benefits, is adopted for gravity drainage in substantially the same manner as it has been made to apply to pumping drainage districts in Louisiana.

The pumping enterprises in Louisiana have practically all been in the low delta lands in the vicinity of New Orleans. About ten years ago a number of these districts were organized and extensive developments were undertaken, but the results have been generally disappointing financially, appar-

ently because there was no established system of crops or agriculture, and much of the development was on a speculative basis with a view to selling the land to colonists. After two or three years of unsatisfactory results, principally because of the expense of maintaining drainage by pumping over large areas which were not in cultivation, most of these enterprises became bankrupt. There is enough successful development, however, at the present time to indicate the way, and the future years will doubtless show extended development, intensive agriculture and truck raising in the low delta section of the Mississippi Valley in Louisiana.

The problem of drainage of the overflow lands in the southern Mississippi Valley states in the last analysis is comparatively limited. There are about six general areas: (1) The St. Francis Basin: (2) the Yazoo Basin: (3) the White River and Arkansas River Basin; (4) southeast Arkansas and northern Louisiana Basin above the Red River: (5) Louisiana west of the Mississippi and south of the Red River; and (6) Louisiana east of the Mississippi River. The Mississippi River banks, as in all alluvial straeams, are built up much above the general level of the overflowed lands. and the Mississippi river levees are constructed along these banks usually without any drainage outlets into the Mississippi river, except through the large tributary streams, so that the outlet for the drainage of the six areas above described are, respectively: (1) The St. Francis River; (2) the Yazoo River; (3) White River and Arkansas River; (4) Red River; (5) the Atchafalaya, the Lafourche and other bayous reaching from southern Louisiana to the Gulf; and (6) Lake Ponchartrain and the Gulf of Mexico.

There is no considerable area of overflowed land in either Kentucky or Tennessee, and practically all of the drainage work in these states consists of straightening streams to reduce or lessen the overflow in comparatively narrow valleys. Most of the streams on which channel improvement has been done in Kentucky are located in the west part of the State and tributary to the Ohio river. and practically all the work in Tennessee is in the west part of the State on tributaries leading to the Mississippi, so that in the aggregate the work done. or to be done in these states is comparatively negligible. However, the soil in these stream valleys is the most productive in their respective localities and usually regarded as a profitable enterprise by the land owners. Most of this work of stream channel improvement is designed with a view to reducing the number of overflows and shortening the period so that it is practicable to raise a corn crop or a cotton crop, but does not give complete protection from over-

flow. Most of the land in these stream valleys is attached to farms on the adjoining hill lands, and the occasional overflow, which does not prevent the production of a crop, is not regarded seriously.

The magnitude of drainage enterprises in these states is well shown by statistics taken in 1920 by the U. S. Census Bureau and issued in the form of bulletins on drainage from which we find that at the close of 1919 the several states had approximately amounts of land organized in drainage enterprises as shown at the left of the following table. It may be interesting to compare the development in the northern Mississippi Valley, also taken from the Census Bureau and shown at the right.

	Acres
Missouri	2,600,000
Arkansas	3,500,000
Louisiana	2,260,000
Mississippi	1,600,000
Kentucky	358,000
Tennessee	360,000
Total	10,678,000

	Acres
Ohio	8,100,000
Michigan	8,700,000
Indiana	9,000,000
Illinois	3,900,000
Iowa	5,200,000
Wisconsin	800,000
Minnesota	9,200,000
Total	45,900,000
Texas	2,160,000

In the northern states, especially Ohio, Michigan, Indiana, Illinois and Iowa, the drainage work has been carried out in great detail and practically all drainage enterprises are 100 per cent effective, so that the future development in these states will be relatively much less than in the southern states. Without having detailed information, but from a general knowledge of the southern states, the present condition of the drainage enterprises is not 50 per cent effective in complete drainage for farming purposes.

DRAINAGE AND MALARIA–MOSQUITO ERADICATION IN ILLINOIS

BY HARRY F. FERGUSON AND A. F. DAPPERT

Drainage work that has been going on for many years in Illinois to reclaim land or make it more productive for agricultural purposes, has resulted in a great decrease in the amount of malaria among the inhabitants because malaria is spread only by the bite of a certain type of mosquito, and this mosquito, like all types of mosquitoes, can breed only when stagnant water is available in which to lay eggs and in which the wiggler stage of the mosquito's life can be passed. The economic saving from decreased sickness and deaths

from malaria, and also other diseases which may have attacked individuals when in a weakened condition from malaria, is not generally taken into consideration in drainage projects, but it really should be included as a benefit as well as the increased productiveness of the land. In some instances the economic saving from decreased illness alone has been undoubtedly far in excess of the cost of the complete drainage work.

Many people in Illinois, especially those residing in the central and northern portions where much of the land already has been drained, believe malaria is practically extinct in Illinois. Such is not the case, for comparatively high death rates from malaria still prevail in the southern portion of the State, which the State Department of Public Health terms the malaria belt of Illinois. When it is considerd that for each death from malaria, statistics indicate that there are about 300 cases, the case rate in the southern counties in Illinois will be seen to be high. Moreover, many deaths are caused by illnesses which would not have been incurred if the individuals had not been previously infected with malaria and thus been materially weakened in physical condition. This is especially true among children, for if children are infected with malaria during their growing years their growth and vitality are probably greatly reduced.

As an example of the economic loss from malaria, reference may be made to Jackson county, in which county the mosquito-control measures which are the basis of this paper were carried on during 1922. Vital statistics records show that there are occurring in Jackson county between 2,700 and 3,000 cases of malaria a year. Assuming that the economic loss per case is $100, which would be a conservative figure and include the cost of medicine, doctor bills, and loss in productive earnings, the economic loss to Jackson county is over $250,000 yearly. Thus that county could well afford to spend a large sum yearly until mosquito-breeding places have been eliminated and would still be ahead financially.

No systematic malaria-prevention work by mosquito eradication was undertaken in Illinois until 1922, when Carbondale made arrangements to maintain complete malaria-mosquito control in that city and an area of one-half mile surrounding the corporation limits. This work was assured by the action of the local Lions Club in guaranteeing to raise a fund of $2,000, by the agreement of the International Health Board to furnish $1,000, by the agreement of the Illinois Central R.R. to drain a number of acres of swamp land adjoining the city at an estimated cost to the railroad of $8.000, and by the arrangement of the State Department of Health to

have a sanitary engineer supervise the work. In the work valuable assistance was also given by the State Natural History Survey and the U. S. Public Health Service.

Before discussing the control measures at Carbondale it may be well to review briefly the life history of mosquitoes, the manner in which malaria is spread by one type of mosquito, and outline the various methods that can be used to eradicate malaria and to prevent mosquito breeding.

Two species of mosquitoes may be mentioned: the Anopheles, the female of which can spread malaria, and the Culex or ordinary pestiferous mosquito. The life cycle of a mosquito is divided into four stages, the first three of which are entirely dependent upon water for their continuance. The entire cycle from the egg to the adult requires from 7 to 10 days, depending upon climatic conditions and water temperature. The mosquito lays her eggs on water The eggs of the Anopheles are laid singly, but those of the Culex are laid in rafts, each raft containing from 200 to 300 eggs. In two or three days' time, the eggs hatch into the larvae or "wigglers."

Anopheles wigglers swim horizontally on the surface of the water and when disturbed, dart laterally. Culex wigglers hang head down, with their tails protruding through the surface, their bodies at an angle of about 60 degrees with the surface, and when disturbed, dart downward. Although living in the water and feeding on small organisms and plant life, the wigglers are at all times true air breathers, securing their supply of air through respiratory siphons located on their tails. In two or three days, the wigglers or larvae develop into pupae. In two to three days more the shell of the pupa splits and the adult mosquito emerges.

The Anopheles mosquito may be distinguished from other types by the definite markings on the wings and by the that when resting or feeding its proboscis and body are in the same line, and at an angle from 45 to 90 degrees with the surface upon which it is resting. The ordinary Culex mosquito has transparent wings and when resting, keeps its body parallel with the surface. The life habits of the two types of mosquitoes are different in many respects. The Anopheles apparently has the better taste and will not breed abundantly in sewage-polluted water. Anopheles Crucians breed most abundantly in swamps and fresh marshes; Anopheles Punctipennis prefer slowly moving streams, while Anopheles Quadrimaculatus choose woodland pools and the shallow portions of lakes and ponds. The Anopheles mosquito very seldom bites in the daytime and its song is much quieter and less annoying than that of other types. It does most

of its work between the hours of sunset and sunrise. The Culex mosquito is very annoying both as to song and bite, and will make its attacks in the daytime as well as at night.

Only Anopheles mosquitoes, and only the female of that species, can spread malaria. In the "dark ages" of malaria it was commonly believed that the disease was caused by breathing or contact with air in low places or which had passed over swamps or stagnant ponds, especially at night-time. Whence the name malaria from two Latin words *"mal"* meaning bad and *"aria"* meaning air. There was a grain of truth to this unscientific but popular understanding of the cause of malaria, for it is true that the Anopheles mosquito that can spread malaria breeds in swamps and stagnant waters and flies lmost entirely after dusk. To spread malaria, the female Anopheles must first bite and suck the blood of a person infected with the disease. Then after the parasites of the disease have undergone certain changes while in the body of the mosquito and have passed through its stomach walls and reached its salivary glands the mosquito can spread malaria to the persons it thereafter bites. Malaria is caused by the animal parasites that are injected into the blood stream by the biting mosquito. The chills and fever accompanying the disease are the result of the multiplication of these parasites and the simultaneous liberation of millions of daughter parasites from their parents.

Malaria control may be conducted along three general lines, any one or combination of which will meet with a fair measure of success: (1) by the prompt and proper medical treatment of infected persons so as to eliminate sources of infection for the mosquitoes; (2) by screening houses and the sick bed and otherwise preventing the mosquito from becoming infected, or an infected mosquito reaching well persons; and (3) by eradicating the mosquito primarily through the destruction or proper treatment of mosquito-breeding places. The eradication of mosquitoes is the most effective and besides preventing malaria gives relief from annoyance. It is a problem for the drainage and sanitary engineer.

The fight against the mosquito must be directed against its water stages, particularly against the wigglers. The mosquito must be killed while in the process of developing and before it takes wing. Along streams the wigglers may be found close to the shore, among the protecting grass and weeds, in the vicinity of drifts, close to logs, among fallen leaves and other accumulations of a like character. The same is true of ponds and pools, the wigglers always being found in the shallow portions among the marginal growths that furnish such excellent protection.

Drainage as an anti-mosquito measure is the most effective. To remove the water is to eliminate the breeding place. Drainage of swamps, marshes and ponds can be effected by the construction of open ditches or tile drains, preferably the latter because of their permanency. In some cases ponds can be drained by vertical drainage. Old ditches with numerous pot holes should be regraded and cleared in order to drain the pot holes and keep the grass and weeds away from the water. A small trench cut in the bed of an old ditch or stream will confine the dry-weather flow and do much to keep the grass and vegetation from encroaching. A tile laid in the bed of an old ditch will remove the trouble entirely. Small depressions and pools can sometimes be more economically filled than drained. The work of clearing as an anti-mosquito measure cannot be over-emphasized. The work appears of little consequence perhaps, yet in many instances at least 90 per cent of the breeding can be destroyed by this work alone. If stagnation of the water is prevented and the marginal vegetation removed, there can be but little breeding.

Places that cannot be drained or filled in should be treated in some manner. Oil is the most efficient as well as the cheapest larvicide. In some cases lime, hog dip, niter cake and other compounds can be used to good advantage. The oil, in addition to creating a thin film over the water surface through which the wiggler cannot penetrate its breathing tube, acts as a poison and kills the wiggler much more quickly than by suffocation. Kerosene is effective and easily spread, but evaporates comparatively rapidly. Kerosene mixed in the proportion of about 4 to 1 with crude oil, makes the best mixture. The oil may be applied by sprinkling oil-oaked sawdust along the edges of lakes or streams, by oil drips, swabs, or sprayers. The sprayer is considered the most effective implement, the Panama knapsack sprayer being the one most widely recommended. Because the oil evaporates or after a while separates so as not to form a continuous film over the surface of the water, oiling must be done at regular intervals of about 7 days. Paris green is strictly a malaria mosquito larvicide. When mixed in the proportions of about 2 parts Paris green and 100 parts of road dust, and strewn with the wind over the marshes and swamps, a great reduction in anopheline breeding can be noted. This is explained by the fact that the Anopheles wigglers or larvae, swimming on the water surface, come in contact with the arsenic flakes, while the other larvae do not.

The stocking of ponds and lakes with the top minnow known as Gambusia Affinis, is an important means of control, for these little fishes swimming near the surface of the

water and near the banks devour the mosquito wigglers. If the fish are present in sufficient numbers, namely, about one minnow for each yard of shore line, and no protection is afforded the wigglers by grass and other growths through which the minnows cannot penetrate they will establish complete control. Rain barrels and other man-maintained mosquito-breeding places in cities, can be controlled by rigid house-to-house inspections, by the passing of mosquito ordinances and by educational measures.

The campaign at Carbondale, directed against the malaria mosquito but which included all species, was very successful. In 1921 there were 267 cases of malaria in the city or 4.26 per cent of the population affected (See Table 1). At the end of the season's work a similar house-to-house canvass showed 19 cases, or 0.3 per cent of the population affected during 1922. The doctors, however, estimated 54 cases for 1922, but even so, the reduction in malaria has been great as a result of the first season's work. The mosquito-breeding places included about 60 acres of cat-tail swamps on the north side, a 40-acre lake on the south side, a number of small ponds, and about 6 miles of ditches and streams, all within mosquito-flight distance of the city. The trouble was augmented by an enormous number of rain barrels and open wells and cisterns. The Illinois Central R. R. provided for the drainage of the cat-tail swamps, while the International Health Board paid one-third and the Lions Club two-thirds of the remaining expense, except the general supervision by State sanitary engineers.

The Illinois Central R. R. constructed the 9,000 feet of ditch necessary for the drainage of the swamps by the dynamite process. The first estimate of cost was $8,000, of which $2,500 was for the actual ditch constructed by hand labor. and the remainder for repairs to culverts, clearing, etc. The ditch was actually constructed for about $1,200 or less than half of the estimated cost by hand labor. A crew of six men and one foreman completed the work in 15 days. The ditch had an average cross-section of about 10 ft. top width, 2 ft. bottom width, and 3½ ft. depth, and cost approximately 17 cents per cubic yard.

A path was first cleared through the cat-tails to facilitate the placing of the dynamite. Holes were punched at intervals of 14 to 18 inches, depending upon the character and condition of the soil, and half-pound sticks of 50 per cent straight nitro-glycerin dynamite inserted to a depth of 16 to 22 inches, depending upon the desired depth of ditch. Only one stick was capped with an electric fuse, and when fired the entire line exploded. By this means sections of the ditch 700 feet in length were constructed in a single blast. While the re-

sulting ditch, of course, was not as smooth and neat as a dug ditch, it was constructed rapidly and most of the swamps drained before the height of the mosquito season was reached, a condition which could not possibly have existed if hand labor or machinery had been employed. It is also believed that the cost of constructing the ditch by hand or machinery would have been far in excess of the $2,500 estimated. A limited amount of clearing by hand will give a smooth ditch.

The 40-acre lake on the south side was abundant with cat-tail growth and pond lilies in a number of small bays, and there was also a fine growth of grass around the edge of the lake, making it an ideal breeding place for mosquitoes. The water level in the lake was dropped 18 in. by cutting the outlet wall, and a great reduction in breeding was at once apparent. The bays were cleared of the cat-tails and pond lilies, and portions of the surface and the edges oiled throughout the season. A careful examination in September failed to find any breeding, when in May before the work started as many as 200 larvae could be secured in a single dip with a small dipper. All ditches and streams in the area were carefully regraded, cleared and kept in a proper condition throughout the season for oiling. All ditches and other collections of water in the area were oiled once each wek. Frequent inspections showed that almost perfect control was established on natural breeding places.

The most troublesome part of the campaign was the control of rain barrels and other man-maintained breeding places. In June, out of 664 open wells and cisterns, breeding was found in 391, and 584 were immediately stocked with Gambusia. A later inspection of 60 wells and cisterns showed that the fish were performing their duties well, only two cisterns being found breeding, and the fish had apparently been removed from these. The control of rain barrels and tubs was accomplished by regular house-to-house inspections. In June the first inspection showed 1.030 containers, 831 being rain barels and tubs which were found breeding mosquitoes. The second inspection in June caught 296 containers breeding, the third inspection 154, and the fourth inspection 206. For the fifth inspection every container holding water in the city was oiled. The sixth inspection caught 19 containers breeding, the seventh 7, and the eighth 11. By the height of the mosquito season, almost perfect control had been established (see Table 2).

The cost of the work, not including the supervision by State sanitary engineers, and exclusive of the work done by the Illinois Central R. R. was $1.598.53 or about 25 cents per capita (see Table 3). The total cost, including that by the

Illinois Central and adding in for the State sanitary engineers' time and expenses, was about $4,260 or 68 cts. per capita. The work resulted in the prevention of at least 200 cases of malaria and relief from the mosquito nuisance. If each case of malaria is figured at $100, a figure which is not absurd, as evidenced by the willingness of the Illinois Central to spend $8,000 to prevent some 125 cases annually among its employees, the net saving to Carbondale from the reduction of malaria alone, was at least $15,700. This charges off the entire cost of the ditching and other work of a permanent character against the first year's economic saving resulting from freedom from malaria. By less expenditures in future years, greater economic savings will thus prevail. Moreover, the draining of the swamps and repairing of ditches and drainage channels have increased the value of the land affected.

Other cities affected with malaria, as well as some which are affected only with the mosquito nuisance, would do well to institute a similar campaign against the mosquito. The fact that Carbondale is preparing to continue the work this year, and Murphysboro, a neighboring city, is contemplating starting control work, furnishes the strongest recommendation as to the success of the project.

TABLE 1. MALARIA CASES AND ECONOMIC LOSS IN CARBONDALE.

Year	Physicians' estimate of cases	Number cases by house census	*Estimated economic loss
1918	200	...	$20,000
1919	200	...	20,000
1920	200	189	18,900 to 20,000
1921	250	267	25,000 to 26,700
1921	250	267	25,000 to 26,700
1922	54	19	1,900 to 5,400

Net economic saving for 1922, based on 1921 losses, allowing for all expenditures by city and railroad for antimosquito work and time and expenses of State sanitary engineers at least $15,700.
*Each case of malaria estimated as a loss of $100.

TABLE 2. REDUCTION IN MOSQUITO BREEDING IN RAIN BARRELS.

Date of inspection	No. residences	Containers breeding	Per cent breeding
June 27 to July 31	456	914	88.6
July 5 to July 21	140	298	29.0
Aug. 3 to Aug. 11	79	154	14.9
Aug. 11 to Aug. 18	130	206	20.0
Aug. 18 to Aug. 29	All receptacles in city oiled whether breeding or not		
Aug. 31 to Sept. 11	17	19	1.85
Sejt. 14 to Sejt. 22	7	7	0.68
Oct. 5 to Oct. 7	9	11	1.06

Percentage breedin gbased on 1,030 containers noted at time of first inspection.
Number of residences in the city approximately 2,000. Population 6,267.

TABLE 3. WORK DONE AND COST — CARBONDALE MALARIA-MOSQUITO CONTROL, 1922

ITEM	Unit	May, June	July	August	September	October	Season
DITCHES CLEARED REGRADED	Miles	3.75	0.20	0.50			
Labor	ManDays	77.50	15.50	30.50			123.50
Cost	$	372.00	74.40	146.40			592.80
Cost per mile	$	99.20	372.00	292.80			133.23
DITCHES MAINTAINED	Miles		0.62	1.00	2.83		4.45
Labor	ManDays		8.50	12.12	31.70		52.32
Cost	$		40.80	58.20	152.20		251.20
Cost per mile	$		65.28	58.20	54.00		56.45
DITCHES, LAKE EDGES OILED	Miles	20.62	19.50	39.34	41.19	19.55	140.20
Oil purchased	Gallons	57.50	51.00	235.00	225.00	149.00	717.50
Waste oil donated	Gallons	49.50	61.00	29.00	30.00		169.50
Total oil used	Gallons	107.00	112.00	264.00	255.00	149.00	887.00
Oil per mile	Gallons	5.22	5.74	6.76	6.22	7.60	6.33
Cost of oil used	$	9.62	8.98	40.01	38.29	25.38	122.28
Labor	ManDays	9.75	9.50	16.50	20.00	12.00	67.75
Cost of labor	$	46.80	45.60	79.20	96.00	57.60	325.20
Total ost of oiling	$	56.42	54.58	119.21	134.29	82.98	447.48
Oiling cost per mile	$	2.73	2.79	3.03	3.26	4.24	3.19
SUPPLIES AND INCIDENTALS	$	34.65	16.49	0.51			51.65
Transportation	$			3.00			3.00
FISH CONTROL, CISTERNS AND PONDS			584.00				584.00
Cisterns stocked	Number		10.50				10.50
Labor	ManDays		50.40				50.40
Cost	$	1st	1, 2	3, 4, 5, 6	6, 7	8th	8
HOUSE TO HOUSE INSPECTIONS	Number	3.00	6.00	16.00	9.10	8.00	42.10
Labor	ManDays	14.40	28.80	76.80	43.60	38.40	202.00
Cost	$	477.47	265.47	404.12	330.09	121.38	1598.53

60 acres cattail swamps drained by constructing 9000 ft. of ditch (dynamite process at 17c per cubic yard 1200.00

TOTAL COST OF ALL WORK, INCLUDING SWAMP DRAINAGE PAID FOR BY I. C. R.R. 2798.53

REGULATION OF COST OF ESSENTIAL COMMODITIES

BY C. M. ROOS

Within recent years in our country unusual interest has been expressed in the regulation of the cost to the public of certain commodities which are essential to the health, comfort, convenience or safety of our citizens.

Because of the very nature of its business of serving the public, the public utility class of industry is the one upon which this regulation or control idea first centered. Thus far all the schemes, ideas, plans and theories of the advocates of public regulation of private industry have been practiced upon and confined to public utilities, in many instances much to the loss, inconvenience and harm of the utility business. On the whole, however, our utilities have submitted gracefully to such treatment as the various regulation advocates have pleased to administer, and have conscientiously responded to the various service and other demands made upon them.

The average utility business today spends much of its energy, time and money in making out reports and statements, submitting them to or appearing before an ever increasing number of regulatory departments, and in revising its systems, methods or processes to conform to ever changing prescribed requirements. This same utility is furnishing the public with a product, served in a more exacting, efficient and acceptable manner and at a cost representing a smaller profit to the producer than any other commodity in our markets. No other commodity represents as great an investment by the producer per dollar paid for same by the consumer as the products of our public utilities. In the open market the consumer finds his dollar has greater purchasing power in buying public utility products than any other commodity. This was true before the time of public utility regulation, and it is more true since. The average public utility today represents not only a vast investment of money, but to bring it to its present state of efficiency it also represents the combined investment of science and invention through many years of research and experimenting, and in addition, the element of risk in developing and promoting the industry has played an important role.

In playing this game of having the other fellow stand by and direct every move which has any connection with the income of the business, our public utilities find themselves victims of regulation which prescribes and limits the income, but allows the utility to be at the mercy of speculators, purveyors and in some cases malicious factions which

dictate unmolested the price which such a utility must pay for such an absolutely essential commodity as coal. During the last several years the experience of all utilities which use coal as fuel should be such an alarming lesson to the country that the attention of our regulation advocates should be directed toward the control of the price of coal. To a public utility man who submits gracefully and uncomplainingly to regulation of his business which represents an enormous investment of money, science and risk, the feeble excuses that are being made for failure thus far to control the cost of coal to the general public do not reflect the serious and proper consideration which this matter should receive.

The product of our coal mines, unlike the product of industry in general, does not represent the results of highly scientific achievement and the investment of immense sums of money. There is coal enough in the State of Illinois alone to keep the wheels of industry in the entire country turning for many years, provided by the Great Designer of the universe, placed within the easy reach of man for his use. Can it be possible that our great people of our great nation will permit a repetition of the coal strike of 1922, and allow a small minority, because of selfishness, ignorance or maliciousness to completely distort, upset and confuse our entire economic structure, resulting in untold suffering and loss?

A commodity so basic in its nature as coal should not be allowed to become the plaything of a very small minority when that small minority has displayed its unwillingness or inability to conduct its business in a manner different from the record it has made during the last several years. There is no good excuse why every man, woman and child in the United States should not have plenty of coal for all necessary purposes at any time of the year at a fair price. A small fraction of the energy, effort, interest and expense of setting up public utility regulation would settle the coal situation and settle it right. Thus far nothing has been done which gives a close observer of the situation any assurance that 1923 offers a coal program much different from that of 1922. A fact-finding commission may be necessary as the first step in remedying this intolerable coal situation, but if actual results are as slow in being secured as are the facts which the fact-finding commission has gathered, the future for a number of years cannot do otherwise than present that which will retard the otherwise bright prospects for good business and improved living conditions in our country.

REPORT OF THE PLUMBING COMMITTEE

There are three different agencies at work on the plumbing problem; namely, the Federal Plumbing Committee, the State Department of Public Health and the Engineering Experiment Station of the University of Illinois. The first two named are working toward the development of a model plumbing code and the last is making investigations of the hydraulic and pneumatic features of plumbing systems.

FEDERAL COMMITTEE.—The subcommittee on plumbing of the Building Code Committee of the U. S. Department of Commerce issued under date of June 17, 1922, its first report which was in the nature of a preliminary report and was sent to numerous engineers and plumbers for review and comment. The Federal plumbing committee consists of George C. Whipple, chairman, professor of sanitary engineering, Harvard University; Harry Y. Carson, research engineer, American Cast Iron Pipe Co., Birmingham, Ala.; William C. Groeniger, consulting engineer, Columbus, Ohio; Thomas F. Hanley, mechanical engineer and contractor, Chicago; A. E. Hansen, hydraulic and sanitary engineer, New York City; James A. Messer, president of James A. Messer Co., Washington, D. C. (resigned); William J. Spencer, secretary-treasurer, Building Trades Department, American Federation of Labor, Washington, D. C.; and Albert L. Webster, consulting engineer, New York City.

The first report of the committee discusses the extent of equipment subject to plumbing regulations and the reasons for public control, describes the lack of uniformity in existing plumbing-code requirements, calls attention to the advantage of standardizing plumbing materials and reducing needless variety of types, states briefly with explanatory notes the reasons for and application of basic plumbing requirements, gives program of tests carried on under the direction of the committee at the U. S. Bureau of Standards, and discusses the design of plumbing systems for small dwellings in the light of experimental results obtained, and states the recommendations of the committee for the design of plumbing systems. The report includes plates showing plumbing installations recommended as suitable for small dwellings.

5* It is expected that a revised or final report will be issued within the course of the next few months. The experiments conducted by the committee at the Bureau of Standards are very interesting and will result in placing plumbing on a more sound and scientific basis and probably result in a simplification of some plumbing installations and thereby an increase in the number of installations made and thus increase the total amount of plumbing work. It might

be mentioned that one conclusion of the committee is that a 3-in. soil stack is satisfactory for the ordinary dwelling and it is thought that future experiments will show that stack sizes can be reduced in high dwellings over what is now standard practice. The committee has recommended against the use of house traps and the problems of antisiphon traps and horizontal runs are being studied.

ILLINOIS STATE DEPARTMENT OF PUBLIC HEALTH.—A law passed by the legislature in 1897 and as amended by the legislature in 1917 provides for the licensing of plumbers by local boards of examiners upon passing examinations and meeting certain qualifications as may be set by the local boards with the approval of the State Department of Registration and Education. Section 5 of this law provides for plumbing ordinances as follows:

"5. Each city, town or village in this State having a system of water supply or sewerage, shall by ordinance or by law within three months of the pasage of this Act and with the advice of the Department of Public Health, prescribe rules and regulations for the materials, constructions, alterations and inspection of all plumbing and sewerage placed in or in connection with any building in such city, town or village; and the board of health or proper authorities shall further provide that no plumbing work shall be done except in case of repairing leaks without a permit being first issued therefor and upon such terms and conditions as such city, town or village shall prescribe."

In order to best comply with Section 5 of the law, the State Department of Public Health prepared a model plumbing ordinance, copies of which are submitted to cities when requests are received for advice in accordance with Section 5. The amended law came in force June 29, 1917 and the model plumbing ordinance of the Department of Public Health was prepared somewhat hurriedly. This model plumbing ordinance can be improved both in substance and arrangement, but review and revision have been postponed pending the results of the studies and work of the Federal plumbing committee which is a subcommittee of the Building Code Committee of the U. S. Department of Commerce. A preliminary report of the Federal plumbing committee has been made available and review and revision of the model plumbing ordinance of the State Department of Public Health has been started and it is expected to issue the new model plumbing ordinance during 1923. A review of plumbing ordinances in cities in Illinois shows considerable variance and in a number of ordinances items are not in conformance with best modern sanitary practice.

ENGINEERING EXPERIMENT STATION.—For the past year or longer the Engineering Experiment Station of the University of Illinois has been active in investigating the hydraulics and pneumatics of plumbing systems with a view to answering some of the many problems which arise in connection with design. A tentative report of their work was presented at the annual convention of the Illinois Master Plumbers Association in 1922.

The most striking feature of this tentative report was the statement that the tests up to that time indicated the possibility of installing the "single pipe" system in small dwellings. Other interesting developments were announced, but as the report was of a tentative nature only, it need not be discussed in detail here. The information contained in the report appealed to the Master Plumber's Association was of such value that they voted to cooperate with the University in the conduct of the tests, and have furnished that cooperation in the form of financial, material, and labor assistance. The tests have been conducted, however, by the University personnel.

A summary of the tests conducted at the University during the past year, together with a brief statement of the conclusion reached as a result of each test, follows:

1. Tests to determine the relation between the depth of water in a trap and its resistance to breakage of its seal. Conclusion: Within the limits of depths ordinarily used in practice, traps with large depths of water offer no greater resistance to breakage of their seal than traps with small depths of water. Depth of water and depth of seal should not be confused.

2. Tests to determine the relation between the diameter of a trap and its resistance to breakage of its seal. Conclusion: Traps up to 4 in. in diameter offer no materially greater resistance to breakage of their seal than traps as small as 1 in. in diameter. Very small traps, such as one-quarter in. in diameter do not offer so great a resistance to breakage of their seal.

3. Tests to determine the relation between the rate of discharge down a soil stack and the pressures recorded in stacks connected thereto. Conclusion: For unvented traps the relation is formula A, below, in which Q is the rate of discharge, p the pressure in the trap, and k a constant dependent on the units used and the character of the trap, soil pipe, and other conditions. For vented traps the relation is formula B, in which m is a constant dependent on conditions including the character of the venting.

$$A.—Q=kp^{0.4} \qquad B.—Q=kp^{m}$$

4. Tests to determine the relation between pressures created in traps and the height of soil stack. Conclusions: Both siphonage and back-pressure are directly proportional to the distance the water falls in the soil stack.

5. Tests to determine the capacity of 2-in., 3-in., and 4-in. soil stacks. Conclusion: The capacity of soil stacks is fixed by the rate at which

water will enter them, not by the rate that it will fall down them. The approximate rate of discharge which will enter the three sizes of pipe mentioned, at any one point, without backing up in the horizontal soil pipe contributing the discharge are: for a 4-in. stack, 125 g.p.m.; for a 3-in. stack, 50 g.p.m.; and for a 2-in. stack, 30 g.p.m.

6. Tests to determine the relation between the pressures recorded in a trap caused by similar rates of discharge into other traps on the same horizontal soil-pipe, either above or below the observed trap. Conclusion: When two toilets are placed on the same horizontal 4-in. soil-pipe the trap on the lower toilet need not be vented but the trap on the upper toilet should be vented. When more than two toilets are placed on the same horizontal 4-in. soil-pipe all the traps should be vented.

7. Tests to show the relation between the pressures recorded in traps on the same horizontal soil-pipe, the pressures being caused by discharge down the vertical soil-stack. Conclusion: For lengths of horizontal soil-pipe less than 25 ft. the pressures on all the traps will be the same if they are vented similarly, regardless of their distance from the soil stack.

8. Tests to determine the limiting lengths and diameters of vent pipes to be used under different conditions. Conclusion: An extensive table has been prepared showing the sizes of vent pipe to be used from ¾-in. to 3-in. in diameter, for rates of discharge from 30 to 300 g.p.m. and lengths of vent pipe up to 100 ft. These sizes are good only when used with 4-in. soil-stack.

9. Tests to determine the relative advantages of crown and loop venting. Conclusion: No difference could be found between the effectiveness of crown and loop venting for pressures caused in traps by discharges down the vertical soil-stack. The relative advantages of the two types of venting have not been tested with discharges along the same horizontal run to which the observed trap is connected, nor for their relative effectiveness in overcoming self-siphonage of traps.

10. Tests to determine the effect of the stoppage of the top of the soil-stack, as is sometimes caused from frost. Conclusion: Many conclusions have been drawn from the observed phenomena, but the final conclusion of greatest practical application is that stacks should be designed so as not to become so clogged as to close off all venting.

11. Tests to show the effect on the pressures in a plumbing system as the result of the use of a house-trap, either with or without a fresh air inlet; but submerging the end of the house-drain or house sewer; or by increasing the length of the house-drain or house sewer. Conclusion: In brief, the addition of a vented house-trap caused no appreciable increase in pressures throughout the plumbing system; the least pressures were observed both with a free discharge and with a vented house-trap. A house-trap without vent allowed greater pressures in the plumbing system than a submergence of 1½ in. of water over the outlet of the house-drain or house sewer. A submergence of 9 in. of water over the outlet allowed excessive pressures throughout the system. Under all conditions the greatest pressures observed were with a length of house drain of about 12 ft., for greater or lesser lengths the pressures in the plumbing systems were reduced.

12. Tests to indicate the causes of self-siphonage and to suggest possible remedies. Conclusions: The conclusion undtr this series of tests is somewhat lengthy, but the most important points to be brought out are: Self-siphonage can be prevented by venting, proper design of the fixture, special design of the trap, or by minimizing the difference in elevation between the outlet from the fixture and the point of entrance of the discharge pipe into the soil-stack.

A general conclusion from all of the tests, and the conclusion of probably the greatest interest to the public, is that it is possible to design a plumbing system involving no more than the number of fixtures found in a single bathroom, without the necessity for venting any traps. The possibility of doing without vent pipes will reduce the cost of plumbing installations in small residences materially. Municipal codes must be changed, however, before the home builder can benefit from these findings. Findings of similar value may be forthcoming from subsequent tests. The above tests and conclusions will be explained in detail in the report to be given to the convention of the Illinois Master Plumber's Association held in Decatur in January. The report will conclude with a list of the tests which are contemplated for the coming year and a statement that it is expected that the program of tests should be completed before July 1, 1923.

F. C. LOHMANN *(Chairman)*, H. F. FERGUSON, H. E. BABBITT.

LIGHTING OF STREETS AND HIGHWAYS

BY A. R. KNIGHT

The question of lighting city streets is one that has always commanded interest because of the intimate connection between illumination and safety and convenience; and the methods used have been changing constantly. During our own lives we have seen used successively gasoline lamps, gas lamps, various forms of electric arc lamps, and lastly, incandescent electric lamps. Today the incandescent lamp is replacing the other methods, therefore only lighting by incandescent lamps will be discussed in this paper.

At no time has any one of the various methods commanded the field long enough to establish itself as the standard method. This has been due partly to the rapid development of lighting units, a development which is progressing as energetically now as at any earlier time, as well as to the constantly changing conception of what is desirable. Until a few years ago comparatively no attention was paid to the esthetic side of street lighting, the idea simply being to have more or les illumination supplied. At present, the matter of general appearance is given practically the same weight as the degree of illumination, and the units to be used are selected as much for their effect upon the appearance of the street as for their efficiency and light distribution.

In the lighting of streets, pedestrian and vehicular traffic must be considered. The ideal condition for pedestrian travel is illumination that is not necessarily intense but which is

uniform. This condition of uniformity is not so important for vehicular traffic, as will be pointed out later. Uniformity of illumination demands lighting units located at short intervals, a requirement that is met naturally by an ornamental system.

Streets can be divided into four distinct classes: (1) residence streets, the traffic on which is due mainly to the residents on the street itself; (2) residence streets handling considerable through traffic; (3) semi-business streets, those on which retail stores and residences are intermingled or streets given over to wholesale and storage houses or factories; and (4) main retail streets. On the streets of all but the first class other factors than those mentioned will enter. For instance, it is a recognized fact that high intensity of illumination has a decidedly stimulating effect and for this reason the main retail districts should have an illumination greatly in excess of the actual needs for safe travel.

Intensity of illumination is spoken of in terms of foot candles. A foot candle is the intensity of illumination on a surface one foot from a source of one candle power or two feet from a source of four candle power, etc. The following minimum intensities of illumination represent present practice fairly well: purely residential streets, 0.02 foot candle (this is about equal to bright moonlight); boulevards or through streets and semi-business streets, 0.04 to 0.05 foot candles; main retail streets, 0.1 or more foot-candles. To determine the size and spacing to produce the above degrees of illumination, it is necessary to know the distribution of light given by the lamp. The shape of the distribution curve can be controlled by the shape of the surrounding globe or by reffectors or by both together.

A comparison will be made of three styles of tops: a ball globe, a top shaped to produce more downward light and a top using a prismatic refractor. A minimum illumination of 0.02 foot-candles can be obtained with the lamps of 100 c.p. alternating on the two sides of the street and with spacings as follows, measured along the street: ball globe, 90 ft.; shaped globe, 100 ft.; shaped globe and refracting dome, 117 ft. The comparative cost per 100 ft. of street for the standards and foundations is $672, $655 and $605, respectively. The saving in first cost shown by the second and third types is in a measure offset by the greater cost of glassware for replacing broken tops and this factor may, in some cases, lead to the selection of the first type. Where higher intensity is desired it can be obtained by using larger lamps or by placing the standards opposite each other or by both together.

Power can be supplied to the lamps either by means of a constant-voltage or a constant-current system. In the con-

stant-voltage system (often called the multiple system) two wires are carried along the streets and 110 or 220 volt lamps are connected between them. The current to be supplied is the sum of the currents taken by the individual lamps and while the current taken by each lamp is small the total may be quite large. The filaments in the lamps are long and of small diameter. This system is not satisfactory because the large current necessitates the use of large wire and also because the lamps do not withstand the vibration due to traffic well.

In the constant-current or series system the lamps are all connected in series, the same current flowing through all the lamps. This current can be made larger than that taken by a single multiple lamp but at the same time being much smaller than the total current in that system. If the current through a lamp is increased the voltage across it is decreased to keep the candle power the same. The total voltage of this system is the sum of the voltages of the individual lamps and may be built up to several thousand volts. The filament of the series lamp is shorter and larger than that of the multiple lamp and therefore it withstands vibrations better. For these reasons the series system is widely used and it is the system that will be discussed here.

There are three types of series systems for supplying power to the lamps: straight series, straight series with current transformers at each standard, and the group system. In the straight series system, all of the lamps supplied by one regulator are connected in series across the regulator. If the district to be lighted is some distance from the control station, it is desirable to have as many lights as possible on one regulator to reduce the cost of cable from the station to the district. This results in the use of high voltage which is undesirable for two reasons: (1) liability of injury to persons coming in contact with any part of the system; and (2) the high cost of cable suitable for such high voltage. On the other hand this system has the advantage of simplicity, the equipment being reduced to a minimum.

In the series system with individual current transformers, an individual current transformer is installed in the base of each standard, thus insulating the lamp and leads up the standard, from the high voltage carried on the underground cables. This system has the following advantages: (1) the life hazard present in the straight series system is eliminated; (2) if high power lamps are used the current transformers can be used to supply the large current required by the lamps while a smaller current is used in the line, thus reducing the cost of line copper required. When use is to be made of

the small sized lamps, this advantage disappears. The disadvantages of this system are: (1) high initial cost; (2) increased number of sources of trouble due to the increase in the amount of equipment needed.

In the group system the lamps are divided into groups and one insulating transformer is used for each group. The advantages are: (1) the voltage of each group can be kept low enough to practically eliminate the life hazard present in the straight series system, nearly equalling, in this respect the individual transformer system; (2) since the voltage for the entire group is lowered, a cheaper cable can be used than is required for either of the other systems. The disadvantages are: (1) the necessity of constructing manholes in which to place the group transformers; (2) a larger number of sources of trouble than with the straight series system. The folowing table gives a comparison of the system with regard to possible voltage to ground from the lamp socket and the cost per standard. The figures given apply to 100 c.p. lamps installed in locations where it is possible to use parkway cable and assuming that 35 KVA regulators will be used to supply constant current to the entire circuit and that in addition 10 KVA series transformers will be used to supply the groups in the group system.

	Maximum Voltage	Cost per Standard
Straight series	5300	110.28
Individual transformer	11	135.28
Group	757	99.78

MECHANICAL FEATURES.—Cable for street lights can be installed in either of two ways. If conduit is laid in the ground, lead covered cable can be pulled into the conduit and connected to the various pieces of equipment. If no conduit is installed, lead-covered cable with two layers each of steel tape and tarred jute around it, can be laid directly in the earth with no other protection, ant connected to the various pieces of equipment. The main advantages of the conduit system lie in the fact that the cable can be replaced at any time without any excavation, while the advantage of the steel taped cable system lies in the lower first cost.

The type of lighting equipment to meet the needs of the different districts can be summarized as follows: (1) The residential section: 100 c.p. lamps on 10½ ft. standards, alternate standards on opposite sides of the street, and steel taped cable; (2) the semi-residential section: 250 c.p. lamps on 12½ ft. standards, spaced as above, and steel taped cable; (3) the semi-business section: 250 c.p. lamps on 12½ ft. standards, spaced as above, and lead covered cable in conduit;

(4) the business section: 250 c.p. lamps on 12½ ft. standards placed opposite one another and lead covered cable in conduit. Alternate lamps on separate circuit to be turned out at midnight. Fairly typical costs per block of 400 ft. for the above layouts, using the group system, with an inexpensive standard and a ball globe are given below. These figures were worked out for a particular locality and are comparative only, local conditions affecting them. Court costs, supervision, inspection and cost of assessment roll for local improvements have not been included.

Residential Lighting

5 10½-ft. standards complete at $53.00	$ 265.00
5 20x20x24-in. foundations at $7.50	37.50
920 ft. 1000-volt steel-taped cable at $240 per 1000 ft.	220.80
50 ft. 1000-volt twin conductor lead-covered cable at $180 per 1000 ft.	9.00
0.40 KW station equipment at $43.40 per KW	17.32
0.40 KW distribution equipment (mains, manholes and transformers) at $246.40 per KW	98.56
Total	$ 648.18

Semi-Residential Lighting

5 12½-ft. standards complete at $65	$ 325.00
5 24x24x30-in. foundations at $8.50	42.50
920 ft. 1000-volt steel-taped cable at $240 per 1000 ft.	220.80
60 ft. 1000-volt twin conductor lead-covered cable at $180 per 100 ft.	10 80
0.825 KW station equipment at $43.40	35.72
0.825 K. W. distributing equipment at $264 per KW	218.13
Total	$ 852.95

Semi-Business Lighting

5 12½-ft. standards complete at $65	$ 325.00
5 24x24x30-in. foundations at $8.50	42.50
5 18x18x24-in. pullboxes at $22	110.00
920 ft. 1000-volt lead-covered cable at $100 per 1000 ft.	92.00
60 ft. 1000-volt twin conductor lead-covered cable at $180 per 1000 ft.	10.80
920 ft. 1-duct conduit in place at $1.60 per lin. ft.	1,472.00
0.825 KW station equipment at $43.30 per KW	35.72
0.825 KW distributing equipment at $264.40 per KW	218.13
Total	$2,306.15

Business Lighting

10 12½-ft. standards complete at $65	$ 650.00
10 24x24x30-in. foundations at $8.50	85.00
10 18x18x24-in. pullboxes at $22	220.00
1840 ft. 1000-volt lead covered cable at $100 per 1000 ft.	184.00

120 ft. 1000-volt twin conductor lead-covered cable at $180 per 1000 ft.	21.60
920 ft. 2-duct conduit in place at $1.70 per lin. ft.	1,564.00
1.65 KW station equipment at $43.40 per KW	71.44
1.65 KW distributing equipment at $264.40 per KW	432.26
Total	$3,232.30

These totals give the following unit costs:

	Cost per Running ft. of street	Cost per Property front ft.	Cost per Standard
Residential lighting	$1.41	$ .81	$129.60
Semi-residential lighting	1.86	1.07	170.60
Semi-business lighting	5.01	2.88	230.62
Business lighting	7.04	4.04	323.23

ILLUMINATION OF HIGHWAYS.—It is becoming desirable to furnish some illumination on the main highways in order to render the use of bright, glaring headlights unnecssary, thereby avoiding a number of accidents which are caused by glare blindness. The problem of highway illumination is greatly different from that of city streets. Since the traffic is almost entirely vehicular, uniformity of illumination is not of so great an importance. The main object is to make it possible to perceive objects or bad spots ahead of the car. Three factors contribute to this perception: (1) direct illumination of the object by the light source; (2) silhouetting of the object against the bright area under the lighting unit; and (3) reflection from the surface of the roadway. Probably the least important is the direct illumination, and for this reason large units spaced fairly far apart can be used.

The lamps should be of the constant-current series type, for which a regulator is necessary. On the basis of 400 c.p. spaced approximately 400 ft. apart, one 35 K.W. regulator will light about 10 miles of roadway. The cost per mile for such an installation would be approximately $1,700 if a pole line is available, and it would only be necessary to support and string the wire and mount the lighting units; and approximately $2,500 if it is necessary to set poles.

SERVICE TESTS WITH THE BATES EXPERIMENTAL ROAD

By CLIFFORD OLDER, *Chief Highway Engineer,*

Illinois Division of Highways

Two outstanding conclusions may be drawn from the general behavior of the Bates road.

First, The load carrying capacity of any design of rigid pavement slab is in direct proportion to the ability of its weakest part to resist bending stresses. The data indicate clearly that under fixed conditions pavements of a definite thickness will carry certain wheel loads indefinitely. The passage of numbers of somewhat heavier loads will result in numerous corner breaks involving heavy maintenance expense. Still heavier wheel loads may quickly result in complete destruction. It is not reasonable to expect local authorities to enforce load regulations. It must be done by a State police force; and any State that does not provide for truck load control faces the early destruction of its paved roads.

Second. Rigid pavements having a uniform thickness or edges thinner than the center are greatly unbalanced in strength and will fail along the edges long before wheel loads are reached that would cause the deterioration of other portions of the slab. Although 50 of the original 63 sections of the Bates road were either partially or completely destroyed, not one case of serious partial or complete destruction of a rigid section occurred that was not directly due to the lengthening and widening of one or more small broken corner areas. The comparative absence of destruction along the north edge of the road is striking, and there the wheels traveled 3 ft. from the edge. Increasing the edge strength of pavements of ordinary width should be of first importance in design.

RICHNESS OF MIX.—The behavior of sections having concrete bases varying in the richnes of mix furnishes food for serious thought. Two different mixes were used: 1-2-3½ and 1-3-5, using the same aggregates. The ratio of sand to stone is practically the same for both mixes, being 0.60 for the 1-3-5 mix, and 0.57 for the 1-2-3½ mix. The difference of strength in favor of the richer mix is by no means marked. A leaner mix with increased thickness to compensate for strength loss may be an economic development under certain conditions.

BRICK WEARING SURFACES.—Of brick with bituminous joint filler, 2 in. sand cushion. 4 in. macadam base; 200 ft. tions, having an aggregate length of 600 ft., of which 400 ft. consisted of 3 and 4 in. lug and lugless brick with bituminous

joint filler, 2 in. sand cushion, 4 in. macadam base; 200 ft. consisted of 3 and 4 in. lug and lugless brick, bituminous filler, 1 and 2 in. mastic cushion, 8 in. 2-course waterbound macadam base. The destruction was simply a rutting in the wheel tracks which progressed to such an extent that all of these sections were completely destroyed and unfit for traffic. While the heavier base sections stood up a little better the difference is not marked.

ASPHALTIC CONCRETE ON WATERBOUND MACADAM BASES.—There were six 200-ft. sections of this type, five having a 2-in. Topeka mix and one having a 3-in. Topeka top consisting of 1½-in. binder course and 1½-in. Topeka wearing surface on a 5-in. one-course waterbound macadam base. The section having the 4-in. novaculite base was destroyed under the first increment of loading. The section having the 4-in. waterbound macadam base was seriously damaged by the same increment. There appears no consistent relation between load carrying capacity and thickness of base. The section having the heavy top stood up best of all; however, the adjacent section having the same total thickness but a 2-in. top while it did not stand up quite as well, behaved better than those sections having thicker bases. This fact might indicate that some factor other than that of having a heavier top accounted for the stability of the 3-in. top section. It was found in bearing capacity tests of the subgrade that the moisture content of the soil was of extreme importance, since the supporting capacity of the soil varied between wide limits at different times of the day as the soil dried out under the sun's rays. It seems possible that the orignal degree of base compaction, or keying with a given amount of rolling, might be dependent upon this factor. Such a condition of course would constantly apply in all sections of the country where rainfalls are frequent. It is of interest to note that in both the brick and asphalt top sections the two-course bases did not stand up as well as the somewhat thinner single-course bases having the same surfaces.

STRENGTH THEORY OF RIGID PAVEMENT SECTIONS.—In 1920 the writer called attention to the apparent weakness of rigid pavements at corners formed by the intersection of transverse cracks or joints with the edges of the pavements. A tentative formula for pavement design was suggested which was based on the assumption that such corners should be designed as unsupported cantilevers. While the critical load supporting capacity of sections with Topeka top or concrete base apparently coincides with the strength of the base, with little or no allowance for the top, yet critical corner failures were not in many cases followed by immediate breaking down of large

areas, as was the case in some of the other rigid types. It is believed that pavements of this type should be designed on the basis of the base thickness alone, being sufficient to resist all corner breaks. Although such breaks might not be followed by further extensive destruction, nevertheless serious items of maintenance costs would be involved. The sections having brick top on concrete base, as was the case with the bituminous concrete top series, showed a distinct ability to resist progressive destruction, although not to as marked an extent.

MONOLITHIC BRICK.—In monolithic brick on concrete, if the total thickness is used as a basis of breaking strength, it does not correspond with the theoretical breaking load. Prior to the truck loading it was observed that at many points the brick surface had separated distinctly from the base. In each section of this type, the first increment of loading caused at one or more spots a cracking of the grout filler between the individual breaks. Although this happened on monolithic sections having a base only 2 in. thick, yet it is a matter of common observation that the base did not immediately fail in all such cases. It should be taken into consideration, however, that the average air temperature was high, and, except where artificial joints were cut, the wearing surface, and perhaps also the base, was under compression due to temperature expansion.

CONCRETE PAVING.—The average modulus of rupture of test specimens representing the sections containing calcium chloride and cemite cement, was distinctly lower than that of the other sections. Further, the 5-in. section in which gravel concrete was used was obviously inferior. Some of the sections having both transverse and longitudinal joints with marginal reinforcing steel also showed somewhat erratic behavior. Most of them showed comparatively high strength. Fatigue tests for about 18 months indicate conclusively that concrete may resist bending loads indefinitely if such loads do not cause fibre stresses in excess of half the modulus of rupture of the concrete. The laboratory tests show that where the loads applied produced a fibre stress of from 5 to 10 per cent in excess of half of the modulus of rupture, fatigue may not follow for from 5,000 to 40,000 repetitions. Loads which produce fibre stresses in excess of 60 per cent of the modulus of rupture are usually followed by breakage after a comparatively few repetitions.

It seems safe to conclude that had the number of applications of each increment been much greater—say 30,000 to 40,000—we would have the breaking load points falling, in the main, between the curve passing through points rep-

resenting a fibre stress of 703 and that representing a fibre stress of 351. It is believed that by means of one or more continuous dowel bars along the edge adjacent corners may be made to act together and thus the breaking and working loads may be increased materially, or perhaps even doubled. Further, it is easily conceivable that if in addition to dowel bars the edges are thickened, they may be made stronger than other portions of the slab.

SAFEGUARDS FOR EXISTING PAVEMENTS.—Many miles of concrete pavement now in service are directly comparable with the Bates road sections and it is not unreasonable to expect such pavements to show corner breakage when high load-thickness relationship prevails. Further, the behavior of the test sections shows that loads much in excess of the critical load, as determined by the theoretical curve, are almost sure quickly to cause extremely serious progressive destruction. It would seem difficult to eliminate the danger entirely. It is suggested that shoulders of gravel, macadam, concrete or other material which could be constantly maintained, preferably silghtly higher than the permanent edge, would help. Such shoulders would ordinarily prevent wheel loads from being applied to the extreme edges of the slab and thus tend to reduce bending stresses. Heavy triangular corner repairs of rigid material will also help, as the obtuse angled corners of the adjacent slab will carry greater loads than right angled corners. Limiting the loads to the strength of the slab would of course solve the problem for old pavements.

SUGGESTIONS FOR IMPROVED DESIGNS. — Designs for new pavements should undoubtedly provide for strengthened edges. This may be accomplished by providing integral curbs which would not strengthen the edge but largely prevent wheel loads from being applied to the extreme edge. It is believed that wider pavements with integral or inverted curbs, using no more or even less material than is now used in many designs, would afford equal or possibly greater load carrying capacity. Merely increasing the width would undoubtedly prolong the life by reducing the frequency of the passing of heavy wheel loads off and on, and along the edges.

Longitudinal joints in concrete pavements reduce the warping due to changes of temperature, thus increasing the possibility of subgrade support along the edges under night traffic. Such joints should be provided with tie bars to prevent spreading, and a corrugated or tongue and groove effect so that the adjacent slabs would afford mutual support.

ILLINOIS NEW DESIGN.—The terms of the Illinois Bond

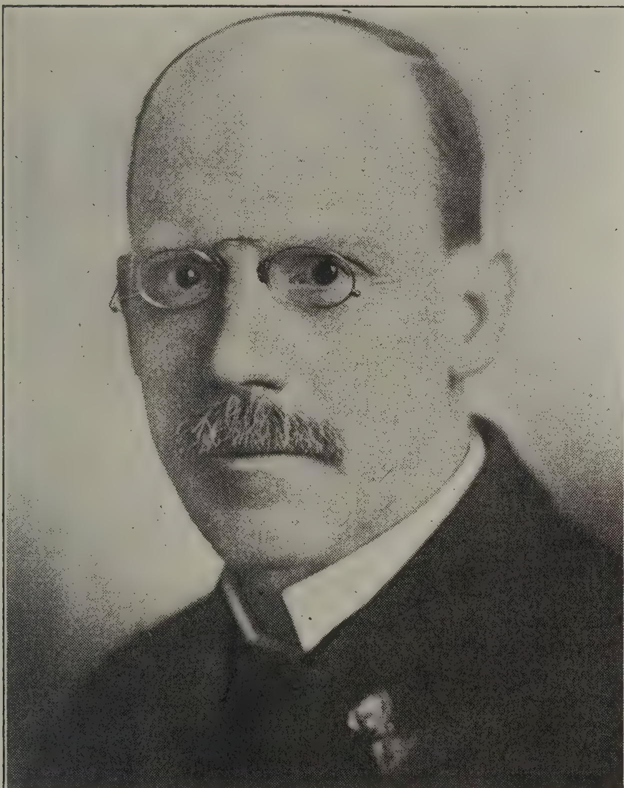
Issue Act prevent general construction of pavements wider than 18 ft. Integral curbs on pavements of this width would probably inconvenience traffic and for this and other reasons are not generally used. To increase the edge strength, the new Illinois design provides for a 9-in. edge thickness, tapering to 6 in. at 2 ft. from the edge. The edge is also strengthened by a continuous ¾-in. round smooth bar. The remainder of the slab is uniformly 6 in. thick. A tongue and groove longitudinal joint is provided across which are placed deformed tie bars.

ILLINOIS VALLEY FLOODS

Conditions responsible for the great floods in the Illinois River in March and April of 1922 are summarized as follows in a report by the State Division of Waterways: (1) Construction of levees along the river, which restricted its discharge capacity and eliminated natural reservoirs; (2) reclamation of land and drainage into tributary streams, permitting greater quantities of water to reach the river in a given time; (3) straightening and draining the Kankakee river in Indiana; (4) addition of approximately 8,000 cubic feet per second from Lake Michigan by the Chicago drainage canal; (5) silt brought down from tributary streams due to higher velocities created by river improvement. From the investigations made, it is stated that a flood as great as that of 1922 must be looked for approximately once in ten years; that greater floods may be expected at longer intervals, and that higher flood elevations may be looked for as additional lands are reclaimed and greater restrictioin is placed on the discharge capacity of streams, if flood plains of the streams are encroached upon as seriously as they have been in the past. A few brief extracts are given below from a report which Mr. M. G. Barnes, chief engineer of he Division of Waterways, read at the 1923 meeting of the Society:

Before the opening of the Chicago drainage canal in 1900, the low-water discharge of the Illinois River at Peoria commonly fell below 2,000 second-feet. The canal now adds more than four times this flow, and the low-water gauge height at that place has been raised 5 ft. Probably the most damaging effect of this additional water occurs at the low-water season, when thousands of acres are inundated which formerly were tilled. Further, this increased flow has hastened the construction of levee districts, which in turn increase the high water stages.

The storms which caused the floods of 1904, 1913 and 1922, passed over only the southeastern portion of the catchment area of the Illinois river. If they had been generally heavy throughout the state the flood would have reached much greater heights. These floods are what may be expected once in a decade, and it is likely that they will be 20 per cent greater about once in 25 years and 30 per cent greater once in 50 years. The construction of reservoirs to control flood heights is not a simple matter under the conditions obtaining along the Illinois River. If storage is not resorted to the levees must be increased in height, or else the damage that will occur probably once in a decade must be accepted. Improvement of the river for navigation purposes by removing the dams and deepening the channel to 9 feet will have a slight influence on the flood stages, mainly in lowering the low water stages. Property damages by the 1922 flood probably exceeded $2,000,000. If this sum had been spent on remedial works it would have gone far towards improvement of channel conditions and protection of property.



E. E. R. TRATMAN

President

Illinois Society of Engineers

1924

LIST OF ADVERTISERS

PROCEEDINGS OF THE ANNUAL MEETING, 1924

The thirty-ninth annual meeting of the Society was called to order by President Babbitt in the Great Hall of the Urbana-Lincoln Hotel, in the city of Urbana at 10 A. M., on January 9th. The president first introduced Dean M. S. Ketchum,a member of this Society and Dean of the College of Engineering at the State University. Dean Ketchum welcomed the Society to the University and offered the facilities of the College of Engineering for our entertainment. He then delivered an address on ''Progress in Highway Bridge Design.''

Hon. James Elmo Smith, a member of this Society and Mayor of the city of Urbana, was then introduced by the President. Mayor Smith welcomed the Society to the city and turned over the key therefor to all of the members present.

President Babbitt responded to these addresses of welcome and assured Dean Ketchum and Mayor Smith that he personally, if no one else, appreciated the welcome to his home town. The president then delivered his annual address, summarizing the activities of the Society, predicting its future, and making suggestions for its conduct and channels for its activities.

The papers read and the addresses made, in the order of their presentation, were as follows:

January 9, morning session; ''Effect of Certain Ingredients on the Strength of Concrete'' by Prof. A. N. Talbot, Member.

January 9, afternoon session; ''Engineering Standards for Municipal Fire Fighting Facilities'' by Clarence Goldsmith, Ass't. Chief Engineer, National Board of Fire Underwriters. ''Well No. 7, University of Illinois'' by Prof. M. L. Enger, Member. ''Wells of the Champaign-Urbana Water Co.'' by W. B. Bushnell, Member.

January 9, evening session. ''Beardstown and The Flood of 1922'' by A. D. Millard, Goodell and Millard, Beardstown. ''Reclamation Projects on the Upper Mississippi'' by C. H. Young, Central States Engineering Co., Muscatine, Iowa. ''The Mapping Problem of the State Geological Survey'' by M. M. Leighton, Member. ''Surveying Instruction at the University of Illinois'' by C. K. Mathews, Instructor in Civil Engineering at the University of Illinois. ''City Planning'' by J. L. Crane, Jr., Member. ''Arbitration in a Survey Dispute'' by W. D. Jones, Member. ''Operation of the Surveyor's License Law in Cook County'' by M. L. Greeley, Member.

January 10, morning session. ''Oiled Earth Roads in Illinois'' by J. H. Reed, County Superintendent of Highways, Cambridge,

Illinois, with discussion at length by Mr. F. L. Sperry. "Relation of Subgrade to Wearing Surface" by W. P. Blair, Member. "Progress in Road Building" by F. T. Sheets, Member. "Changes in Chicago Paving Ordinances" by J. B. Hittell, Member. "Court Decisions Affecting Local Improvement Acts" by Attorney Oscar C. Hoose, Bloomington.

January 10, afternoon session. "Current Problems in Illumination" by C. E. Weitz, Engineering Department National Lamp Works, Cleveland, Ohio. "Engineering Features in Mine Development" by Cecil W. Smith, Chief Engineer, Illinois Coal Corporation, Chicago, "The Tendency Towards Centralization of Power Development" by W. L. Abbot, Chief Operating Engineer, Commonwealth Edison Co., Chicago. "Fatigue of Metals" by Prof. H. F. Moore, Member. "Relations between Public Utilities and the Public" by John F. Gilchrist, Vice-President, Commonwealth Edison Co., Chicago.

January 11, morning session. "Illinois Special Assessment Law" by P. E. Green, Member. "Chemical Data," "Ultra Filter for Sewage" and "Report on Sewage Treatment Plants" by Dr. A. M. Buswell, Member. "Sewage Treatment Works of the Sanitary District of Chicago" by Dr. F. W. Mohlman, Chief Chemist, Sanitary District of Chicago. "Urbana-Champaign Sewage Treatment Works" by C. R. Velzy, Member. "Efficiency of Different Types of Filters" by R. I. Randolph, Member. "Dosing and Distributing Systems" by L. E. Rein, Member.

An Inspection Trip of the laboratories of the College of Engineering of the University of Illinois occurred on the afternoon of January 9th. A more extensive inspection trip was made on the afternoon of January 11th. This included, in the order of places visited, the construction work on the Urbana-Champaign Sewage Treatment Plant, the construction work on the Illinois Memorial Stadium, and the grade elevation and separation work on the Illinois Central Railroad.

The Annual Dinner was given on the evening of January 10th. Addresses were made by Hon. Roger F. Little, member of the State Legislature; Hon. James Elmo Smith, Member, Mayor of Urbana; President-Elect E. E. R. Tratman, and Professor A. N. Talbot, Member. The dinner was followed by dancing which lasted until midnight.

The Annual Business Meeting was held in the afternoon of January 10th. The order of business was as follows:

Election of Officers. The following officers were elected; President, E. E. R. Tratman. Vice-President, A. L. Webster. Trustees, W. B. Bushnell, and M. L. Greeley.

Place of Meeting for 1925. The invitation of the Chicago Association of Commerce to meet in Chicago, was accepted.

Election of New Members. The following were elected to membership: M. S. Ketchum, F. G. Geraghty, A. M. Danely, W. M. Olson, C. R. Velzy, G. H. Radebaugh, G. W. Craig, C. B. Schmelt-

zer, A. D. Millard, F. E. Richart, C. V. Swearingen, H. F. Moore, W. W. Kerch, M. P. Flickenger, L. C. Laswell, W. H. Allen, Stanley Krebs.

Resolutions. The following resolutions were adopted:

Whereas, the University of Illinois is conducting courses in Land Surveying, and *Whereas,* such courses are not well adapted to the short periods available during the scholastic year, and therefore the students taking this course are not able to have the training and experience, which, should enable them to perform accurately, capably, and effectively the work which they should reasonably be expected to do on graduation, *Now Therefore be it Resolved,* that this Society recommends the establishment by the University of Illinois of a Summer Camp for Land Surveying in its various types, which course shall be required of all students in Civil Engineering.

Whereas, during the past year the Illinois Society of Engineers has lost through death, three of its well known and much loved members; Charles E. Chester of Shelbyville, E. J. Chamberlain of Pittsfield, and H. D. White of Springfield, *Now Therefore be it Resolved* that we greatly deplore the loss of these men from our technical circle and extend to their families our sincere regret and sympathy.

Whereas, the Illinois Society of Engineers is composed of engineers practicing in all parts of the State of Illinois; *Whereas,* we, the Members of said Illinois Society of Engineers, are in Annual meeting assembled in Urbana, Illinois, and have knowledge of the conditions of the streams and lakes in the State of Illinois, and, in addition, are acquainted with the problems of planning, construction and operation of Sewage Treatment Works to handle the sewage of our cities, and purify it before discharging it into the streams on which the cities in which we live are located:—*Whereas,* we recognize the magnitude of the problem confronting the Sanitary District of Chicago in the treatment of the sewage of a population exceeding three million, which population is now increasing at the rate of 700,000 every ten years;— *Whereas,* we further recognize that the method of dilution originally installed has been successful, but through the growth of the City of Chicago and its industries has been so overloaded that extensive supplementary works must rapidly be installed:—*Whereas,* in the operation of the works for the protection of the water supply of Chicago, and for the removal of the Chicago sewage, we believe the continuance of the use of the Main Drainage Channel of the Sanitary District of Chicago is essential, and with a flow to the limit of its capacity, namely; 10,000 cu. ft. per sec.; *Now, Therefore, Be It Resolved,* that we endorse the continuance of the use of the dilution process of sewage disposal within the limits of the existing works with a flow from Lake Michigan up to 10,000 c. f. s., with provision for treatment by supplementary works of the excess population over and above that cared for by the dilution method,

and further that the Secretary be and is hereby directed to send a copy of this resolution to the Representatives and Senators from Illinois in Congress assembled.

Whereas, the Illinois Society of Engineers has heretofore urgently requested the hastening of topographic mapping in Illinois to meet the pressing needs of a base map for our many engineering projects, and to avoid costly and wasteful duplication incident to individual surveys where no public base map is available; and *Whereas,* an effective coöperative program has been made possible between the United States Geological Survey and the Illinois Geological Survey by the generous provisions of the Temple Bill of the Sixty-seventh Congress, enabling a Federal apportionment of $50,000 to Illinois for the present year to match an equal sum from the State; and *Whereas,* the accomplishments during the current year have been fully commensurate with the funds appropriated; *Now, Therefore, be it Resolved,* that the Illinois Society of Engineers in convention assembled at Urbana this tenth day of January, 1924, express its hearty approval of the provisions of the Temple Bill and instruct our United States senators and representatives from Illinois to actively support individually and collectively any measure for topographic mapping proposed by the Department of the Interior or from any other proper source which will reappropriate the equivalent of the Temple Bill and afford Illinois and other states the full support which the Temple Bill now affords; *And be it further Resolved,* that a copy of these resolutions be spread on the minutes of the present convention, a copy be sent to each of the United States senators and representatives from Illinois, and a copy be provided the various newspaper syndicates for publication.

Resolved, That in regard to the recent summary dismissal of Mr. A. P. Davis, a highly competent and experienced engineer and executive, from the position of Director of the U. S. Reclamation Service, the Illinois Society of Engineers makes emphatic protest against this action of the Secretary of the Interior and against the unjust and sinister method in which this dismissal was effected, namely, by abolishing the position, thus leaving the Director without opportunity for redress; *Furthermore,* protest is made against the immediate creation of practically the same position, but under another title, for an appointee whose main qualification appears to be political influence. *Resolved,* That the position in question is one requiring both technical skill and administrative ability, both of which have been exercised by Mr. Davis for several years with marked benefit to the Reclamation Service, the public, and the development of the arid region. And such political interference with work of such importance is a serious detriment to the public welfare, to the work of the Reclamation Service and to the civil service principle, as well as to the engineering profession. It is urged that there should be an investigation by Congress as to this case of dismissal and appointment. *Resolved,* That this resolu-

tion be sent to the President of the United States, to the Secretary of the Interior and to the Illinois representatives in Congress, and also to Mr. A. P. Davis.

Resolutions of thanks were directed to be sent to The Bates and Rogers Construction Company through their superintendent Mr. Rogers, to the Illinois Central Railroad through their engineer Mr. Dunn, to English Bros. Construction Co., to the Urbana-Champaign Sanitary District, and to Pearse, Greeley and Hansen, through their engineer Mr. C. R. Velzy, all of whom were instrumental in making possible the success of the inspection trip on the afternoon of January 11th.

Resolutions of thanks to the faculty and students of the University of Illinois, were adopted, for their hospitality and efforts in entertaining the Society and for their interest in attending the meeting and in arranging for the inspection trip of the Engineering College Laboratories.

A vote of thanks was sent to the management of the Urbana-Lincoln Hotel for the excellent service and accommodations which were given the Society during the meeting.

REPORT OF PUBLIC WORKS CONFERENCE

The report of our representative, Mr. C. G. Elliott, at a conference of the Federated Engineering Societies was read as follows: "I was appointed a delegate to represent the Illinois Society of Engineers at a conference of the Federated American Engineering Societies called to meet at Washington, January 9th, 1924. This was named a Public Works Conference and was called by the American Engineering Council to consider the general plan for the reorganization of the executive departments of the Government.

About seventy separate engineering organizations were represented in the conference. With a few exceptions the general plan of reorganization proposed by the chairman of the joint committee, commonly known as the Brown Plan, was endorsed. The Conference's committee on resolutions emphasized the view that all non-military works of construction should be placed in one group, to be known distinctively as the Department of Public Works. It was voted to set in motion, under the direction of the American Federation of Engineering Societies, a nation-wide movement to establish such a Department. Some differences of opinion were expressed with regard to the details, but a general sentiment prevailed unanimously favoring the move.

Amendments to the Constitution. The following amendments to the Constitution were proposed. Art. V, Sect. 2, dues. "The Annual Dues are due and payable in advance on January 1 of each year," Art. VI, Sect. 4. The management of the Society shall be vested in a Board of Direction, consisting of . . . (no further change) Art. VI, Sect. 1. The officers of this Society shall be a President, a Vice President, a Secretary-Treasurer and four Directors. Also change the word trustee to the word director

wherever it occurs in the Constitution, and the title Executive Board to the title Board of Direction wherever it occurs in the Constitution. These amendments were approved and ordered presented to the Society as required by the Constitution.

REPORT OF THE SECRETARY FOR THE YEAR 1923

In resigning the position of secretary after twenty-one years of service, it seems worth while to note that at the beginning of 1903 the Society had about 120 members and a balance of $48, with some bills then unpaid. In January, 1924, there were 265 members and a balance of $996.81, including $400 in liberty bonds.

The increase in membership has been relatively slow, partly owing to the fact that it has been the consistent policy to drop from the list each year the members who are two years in arrears and show no desire or intention of paying their back dues, after ample notice has been given. In this way there is little dead timber in the current membership list. With the new section for mechanical, electrical and mining engineers, it is hoped there will be a more rapid growth in membership. But even so, there should be a greater increase in the number of civil engineers and surveyors, who will continue to constitute the main portion of the Society.

Individual members can assist most effectively in accomplishing this increase, since every engineer meets others in his business life and many have other engineers as associates or assistants. In his regular business contact with others, therefore, it is easy to point out the advantages of membership in the Society and to hand out an application blank. Or, if he prefers, he can notify the Society headquarters of the prospective member and letters and application blanks can then be sent officially to the engineer named.

During the year 1923 a number of requests for information were received by the Secretary, relating to various subjects and particularly as to the names of engineers who might be engaged to design or report upon local water supply, sewerage and drainage projects. In such cases several names were given for the information and selection of the enquirer. Strange to say, comparatively few communications were received from members, although endeavor has been made to induce members to regard the Society and the secretary's office as a source of information. Closer contact of the members in general with the Society's administration is very desirable.

Exchange of "Proceedings" was arranged with two other State societies: Iowa and Wisconsin. Some societies which formerly made exchanges have stopped the publication of annual proceedings or have so limited their editions that they cannot provide for exchanges. This change is due mainly to the great cost of printing and publication since the World War. Some years ago we had full exchanges with six or seven societies. When this practice was broken up, our own members were asked to specify which society's "Proceedings" they wished to have. It was a great surprise to find the large majority of members stating that they did not care

for any exchanges. However, in 1923, the Iowa and Wisconsin "Proceedings" were sent to all our members. Our own "Proceedings" have been sent as usual to the libraries of a number of technical schools and associations, as follows:

American Society Civil Engineers	University of Illinois
American Society Mech. Engineers	University of Wisconsin
Western Society of Engineers	University of Michigan
Illinois State Library	Washington University (St. Louis)
Library of Congress	Northwestern University
Chicago Public Library	Purdue University
John Crerar Library	Rose Polytechnic Institute
New York City Public Library	Lewis Institute
St. Paul Public Library	U. S. Geological Survey

Since the Society is an incorporated body, the usual certificate of election was filed with the county clerk for registration. This annual registration is required to maintain the advantages of incorporation. Without this, each and every member is liable for debts of the Society; but with incorporation, the liability is against the Society only. The usual financial statement is submitted herewith, covering the year 1923.

In conclusion, it is desired to express sincere thanks and high appreciation for the honor and confidence conferred by the Society for the past several years, and to hope that the new secretary will receive the same support and confidence. That the Society may have continued success and be of increasing benefit to the engineers of Illinois is the sincere wish of

E. E. R. TRATMAN
Secretary and Treasurer (Retiring)

FINANCIAL STATEMENT. The Secretary-Treasurer presented the following financial statement to December 31, 1923.

Bank Balance, December 31, 1922		$ 237.32
RECEPITS, 1923:		
Annual Dues	$887.00	
Entrance Fees	69.00	
For Special Assessment Fund	23.00	
Sale of Proceedings	9.00	
Advertisements	642.50	
Balance from Special Assessment Fund	92.94	
Reprints	29.43	
Drawn from Reserve for Special Assess. Fund	100.00	
Total for 1923		$1,852.87
Total		2,090.19
EXPENDITURES, 1923:		
Printing and Distributing "Proceedings"		596.61
Printing and Stationery		180.38
Bulletins		70.85
Stamps and Telegrams		64.25
Express and Freight		8.81
Typewriting		53.30
Convention, 1923		23.00
Stenographer, 1923 Convention		35.00

Programs and Distribution, 1923		89.90
Badges, 1923		16.45
Certificate of Election of Officers		.55
Secretary		250.00
Subscription National Drainage Congress		15.00
Subscription Illinois Municipal Review		1.00
Executive Committee, Traveling Expenses		34.98
Refund on Excess Dues		1.00
Committee on Legislation (Spec. Assess.)		200.00
Committee on Legislation (Spec. Assess.)		23.00
Reprints		29.43
Total Expenditures		$1,693.51
Total Receipts		2,090.19
Bank Balance, December 31, 1923		$ 396.68
Savings Acount, reserve	$200.13	
Liberty Bonds	400.00	

ELECTION OF SECRETARY-TREASURER. Immediately following the Business Meeting of the Society the new Executive Board was called together and elected H. E. Babbitt to succeed E. E. R. Tratman as Secretary-Treasurer.

ATTENDANCE. Fifty-nine members of the Society attended the meeting and one hundred and three guests signed the register. There were probably as many guests in addition who did not sign the register.

ILLINOIS DRAINAGE LEGISLATION

The Illinois legislature at its 1923 session amended the Drainage Act so as to provide that no bonds could be issued without submitting the question of the bond issue to a vote of the people of the District and that the rate of taxation for all purposes, exclusive of bonds and interest, should not exceed 0.66 per cent. Prior to the amendment, the rate for all purposes exclusive of bonds and interest was 1.33 per cent, or in other words the rate was reduced 50 per cent. In spreading the 1923 taxes for the East Side Levee and Sanitary District, of East St. Louis, the county clerk of St. Clair county felt that he must abide by this amendment and, therefore, refused to apply a rate for general purposes, exclusive of bonds and interest, in excess of 0.66 per cent.

Attorneys for the District contended that the amendment was not legally passed in the legislature, and in a mandamus proceeding in the Circuit Court to compel the couny clerk to extend the taxes according to the law prior to its purported amendment in 1923, the Circuit Court held that the Act had not been legally passed. The county clerk, therefore, based the taxes on the law as it existed prior to the attempted amendment in 1923. The basis of the court's decision is said to have been that the Senate, in receding from an amendment in which the House had refused to concur, had voted without a legal majority being present.

While the law in question is general in its terms, the East Side District appears to be the only one now operating under its provisions. The principal differences between this law and the Levee

Act are: (1) it contains a provision allowing the organization of districts including territory in more than one county; (2) the manner of taxation is changed; instead of being a special assessment on property for benefits it is a general tax on all classes of property, on the same basis as taxes are levied by cities and villages.

THE TENDENCY TOWARD CENTRALIZATION OF POWER DEVELOPMENT

W. L. ABBOTT

Chief Operating Engineer, Commonwealth Edison Co., Chicago

The development of the electric lighting industry has been pretty much the same in all communities—originally some individual installed a small isolated plant for his own service; later, as an accommodation, he extended that service to neighbors. In time a number of these lighting systems were consolidated as a central station and became a separate business. Two or more of these stations, as neighbors, would become so violently competitive that consolidation was inevitable to prevent destruction.

This process of enlarging and consolidating has continued ever since and is still continuing. Few, if any, large cities now have more than one lighting company, and the lighting business of neighboring towns and smaller cities is being grouped into vast systems, whose transmission lines cross state lines and, being supplied with power from large and efficient plants located at strategic points, render a service whose dependability and cheapness could not possibly be approached by the smaller systems which were consolidated to make the larger ones. Evidence of this fact is given by the coal mines, which no longer can afford to generate their own power with their own slack, but instead are taking it from high voltage transmission lines fed from some distant power house, which burns perhaps the screenings from the same mines, with its original cost increased by a freight charge.

In this connection it would be of interest to trace how this consolidation of power has reduced the fuel demand. Originally a manufacturer installed a dynamo driven from a belt off the main shaft, a hand-fired boiler and plain slide-valve engine for prime mover, usually operating at about half capacity, and of that amount of power probably one-half was lost in friction. Under such conditions, twenty pounds of coal per kilowatt hour would be fair. The next step was to install a high speed engine of 100 H. P., driving belted generators, which would in a day's run—full load and light load—produce a kilowatt hour on say fifteen pounds of coal. The next step was the consolidation of two or more of these isolated central stations into a group, supplied with power from the best and best-located plant of the group. It was found that with an improved load factor and larger units, the coal consumption was re-

duced to ten pounds per kilowatt hour. The next step was to connect these groups into larger ones of 5000 kw. capacity, favorably located as regards condensing water and rail connections, having compound condensing engines and capable of delivering a unit of energy for six pounds of coal, and when turbines were substituted for the reciprocating engines the coal consumption dropped to four pounds. A plant of this size can reach out its arms and gather in all the business within a radius of thirty miles or so.

This was about the most efficient combination of station power and transmission lines, unless it happened that the power demands of the city in which the plant was located were such that the use of turbines up to 10,000 kw. capacity was practicable, in which case the efficiency was further improved to three pounds, warranting the construction of still longer lines to reach more remote localities. But the process of consolidation is not stopping there. The tendency now is to connect all of the power of the Middle West into plants having a capacity of 40,000 kw. or more and an efficiency of two pounds of coal per kilowatt hour. This is brought about by the development of higher tension transmission, by the increasing density of power all over the country, and by the increasing cost of fuel, which in many cases renders the cost of power prohibitive when generated in small quantities.

It is frequently remarked that the Middle West is under great handicap because it has so little water power. It is even suggested that hydro power from the Rocky Mountains, more than a thousand miles distant, be transmitted here on high tension lines to conserve our coal and lower the cost of power.

This proposition, although interesting and having some elements of plausibility when considered in the light of what the mountain states are themselves doing with this power, is, upon analysis, wholly absurd, as it is unable to compete in price with power generated with coal from our own coal fields. It is also suggested that the power plants be located at the mine and the power sent from thence to the remote center where it is principally to be used, thus saving the cost of the railway haul. But for some reason this is not done in any large way, the obvious explanation being that with summer temperatures, 500 pounds of circulating water are required for each pound of coal burned, and with a plant developing 50,000 kw. there would be required in the neighborhood of 200 cubic feet of water a second for condensation, and streams of that flow in summer rarely abound on the prairies near coal mines, while the cost per kilowatt of a transmission line for a plant of less capacity would be prohibitive.

It is true that a smaller supply of condensing water might serve such a plant if cooling towers or a cooling pond were used, but if the heat of 60 tons of coal be used each hour principally to warm up the water in such a pond, its temperature would be bound to go far above that of the atmosphere, with material reduction of plant efficiency and capacity.

This is the obvious and usual reason given why steam-electric power is not developed in quantity at the mines and transmitted long distances by wire, and while this answer is usually correct and sufficient, it is not always so, as there are many places where coal is produced on the banks of rivers, and yet the coal leaves the mines by rail for power plants 100, 200, or 300 miles away. We are therefore forced to the conclusion that rail transmission of power in large quantities is still cheaper than wire transmission, and, curiously enough, the greater the distance the less advantageous becomes electric transmission.

To illustrate, assume a water power capable of generating 100,000 kw. and a coal mine, each 100 miles from a large market for power. Assume also that a steam-electric plant can be built for $120 a kilowatt of capacity and that the water power can be developed at a cost of $200 per kilowatt; a high voltage double-tower line of two circuits each will cost $35,000 a mile; coal can be bought at the mine for $2.25 a ton, and that a kilowatt-hour can be generated on 1.8 pounds of coal, load factor 75 per cent and transmission losses 1 per cent for each twenty miles. While we are about it, let's also see what the relations would be at 200 miles and at 300 miles.

Problem: Shall we (a) develop the water power and transmit the energy; (b) build the steam plant at the coal mine and transmit, or (c) build a steam plant where the power is to be used and ship the coal to it from the mine?

Right here it might be interesting to any railroad man present to have a layman explain the system by which railroad coal freight schedules are made up. I do not know that there really is a system by which these schedules are constructed, but here is a rule that will loosely fit most of them in this locality: A charge of four-tenths of a cent a ton mile, plus a base rate of one dollar a ton.

For example, from Braidwood to Chicago is 57 miles; multiplying by 0.4 gives 23 cents; adding the base rate of $1.00 gives $1.23. The actual rate is $1.48. From Danville to Chicago is 123 miles. This by the formula should be $1.49; the rate is $1.55. Springfield, 185 miles away, should have a rate of $1.74; it is $1.65. Harrisburg, 306 miles distant, should have a rate of $2.24; it is $2.16. Applying this freight rate formula to the problem above stated, we obtain the results given in the table.

100-MILE LINE:	Hydro	Steam at Mine	Steam in City
Cost of Power Plant	$21,000,000	$12,600,000	$12,000,000
Cost of Line	3,675,000	3,675,000	----------
TOTAL	$24,675,000	$16,275,000	$12,000,000
Overhead at 12%	$3,000,000	$1,853,000	$1,440,000
Tons Coal Burned	---------	(622,000)	(592,000)
Mine Cost	---------	1,400,000	1,332,000
Freight	---------	--------	829,000
	$3,000,000	$3,253,000	$3,691,000

200-MILE LINE:			
Cost of Power Plant	$22,000,000	$13,200,000	$12,000,000
Cost of Line	7,350,000	7,350,000	--------
TOTAL	$29,350,000	$20,550,000	$12,000,000
Overhead at 12%	$3,532,000	$2,466,000	$1,440,000
Tons Coal Burned	---------	(651,000)	(592,000)
Mine Cost	---------	1,465,000	1,332,000
Freight	---------	--------	1,172,000
	$3,532,000	$3,931,000	$3,944,000
300-MILE LINE:			
Cost of Power Plant	$23,000,000	$13,800,000	$12,000,000
Cost of Line	11,025,000	11,025,000	---------
TOTAL	$34,025,000	$24,825,000	$12,000,000
Overhead at 12%	$4,080,000	$2,980,000	$1,440,000
Tons Coal Burned	---------	(681,000)	(592,000)
Mine Cost	---------	1,532,000	1,332,000
Freight	---------	--------	1,302,000
	$4,080,000	$4,512,000	$4,074,000

From this table it appears that with coal at prevailing prices in this territory, water power within two hundred miles of the place where its power can be used has some intrinsic value as such, but beyond that distance it had better be developed for its scenic value; while in case of a power plant at the mine mouth and with an abundance of condensing water at hand, it too would be outclassed by a power house supplied by rail-borne coal, located in the big city one hundred miles or more distant where the power is to be used.

This estimate is based on using a double-tower line of two circuits each on a private right-of-way with the best modern construction, designed to carry at 75 per cent load factor the 100,000 kw. base of a load that would amount to 350,000 kw.

If the hydro plant or the steam plant at the mine were obliged to carry enough of the load to reduce its load factor to 50 per cent it is probable that all three would be on about the same basis at 100 miles, and beyond that distance the plants operating over transmission lines would begin to fall behind the plant located near the place where its power is to be used.

It is nevertheless true that some water powers near coal mines are being developed, but it is also true that in most cases such developments are economic errors, and it is often being done because an undeveloped water power is a menace to the local power company if it is left undeveloped. Not because some potential rival could make money by the development, but because he might not know that he could not.

I have, for the purpose of this paper, which deals only with the Middle West, included in that part Western Pennsylvania and Eastern Kansas and everything from the southern borders of Missouri and Kentucky north to the Great Lakes and the Canadian border. Of this whole territory, about one-sixth of the power is hy-

draulic and five-sixths steam, the largest single water power being that at Keokuk, which is something over 100,000 kw. The next largest series of water powers is in the Southern Michigan peninsula, aggregating 86,000 kw., located on water powers along the Au Sable, Manistee and Grand Rivers, flowing from a hog-back water shed running the length of the southern peninsula and having an elevation of 500 feet above the lakes. This water power is supplemented by 114,000 kw. of steam.

The northern part of Wisconsin has an elevation of some 1200 to 1500 feet above sea level, while the Mississippi River along the Wisconsin border has an elevation of from 600 to 700 feet. Therefore, the Wisconsin rivers which discharge into the Mississippi have a fall of 500 to 800 feet in their short, turbulent courses, affording many opportunities for the development of water power. Some such developments are indicated on the Wisconsin and the Chippewa, and other developments are under construction or consideration.

The great economies possible by consolidating small properties have not been overlooked by capital, and there has long been a scramble for the richer sections of the country, with the outcome that there has resulted a hodgepodge of systems, with boundaries more bizarre than those of the various German states. Many local combines are developing and gaining strength and territory, but elsewhere they are being taken over by large holding and operating companies and united into systems. The territory of any one holding company is not contiguous. In fact, all of the holdings are quite spotty, and while there may be some friction around the edges, for the most part these giants are on such neighborly terms with each other that they not only do not fight much, but they interchange power for mutual assistance. At present they are using all the money they can get to acquire and develop neighboring areas and the business within the territories already covered, but I anticipate that the process of consolidation will continue and the present erratic lines will dissolve, forming huge interstate combines capitalized at billions, supplying dependable power in unlimited quantities and at prices that eventually will shock steam locomotives off the rails and will put into the hands of each of our factory operatives ten times the amount of power that his foreign competitor has.

I have endeavored to give you a mere glimpse of the present status of a great business, the magnitude of which few comprehend and whose present rate of growth is such that the business more than doubles every twelve years. The capital necessary annually for this development mounts to fantastic heights, as was said of the German war debt, and yet it is forthcoming as fast as needed. Not as was formerly the case—principally from large capitalists, but from the people—wage earners and others of moderate or small means, and many of whom are customers of the lighting company,

in whose future they have confidence and whose interest they jealously guard.

The expression "Public ownership of utilities" once to those utilities had a sinister meaning, but they took up the challenge and made the threat come true, although in a way not expected. They changed it from public ownership to ownership by the public, and as such no demagogue dare assail its interest. In Illinois alone probably one hundred thousand voters are utility stockholders, and all are voting and vocal when their interests are threatened.

No other industry has the rate of growth, no other business has been devolped on such strictly scientific lines. Other industries have grown up on intuition and tradition, cut and try seeking in the dark, or rather not seeking but stumbling over facts, some of which are recognized as discoveries; but here is an industry that was led by scientists from the start, whose every development of abstract theory quickly found a practical application, with a practical reward to the discoverer.

The field is still open with a wider front than ever and the rewards are to the diligent and courageous, be they investigators, executives, constructors or operators; and while not all aspiring young engineers can go to the top at once, they can follow the steep road that leads in that direction or build a new road for themselves.

CURRENT PROBLEMS IN ILLUMINATION

C. E. WEITZ
National Lamp Works

The illuminating engineer has given us good equipment and methods for its use in taking care of most any lighting problem that comes up in the major fields of lighting. He has established certain facts on the value of proper lighting and has recommended standards of lighting much in excess of those previously thought adequate. The illuminating engineer, if he is rightfully to be called an engineer, must turn to new things, establish new truths, pioneer into new facts which influence this chosen field. To explain the new angles that are now engaging the illuminating engineer's time and attention, I want to draw freely upon an Electric World editorial which appeared a few months back.

Electricity, as you know, has been a boon to mankind in many ways. It has served to produce light when and where it was wanted; it has come to perform the tasks of industry and of the household; it is used directly in manufacturing processes of various kinds; it provides warmth, it provides flexibility, and the electrical industry has been constantly at work devising new ways in which it can serve. But it was only recently that there came a realization that light, the earliest form of service by electricity, had much

latent ability to be of far greater service than had previously been thought possible.

All early work by illuminating engineers in their attempt to provide adequate light for factories and other industrial establishments was directed toward the proper distribution of light to give virtually uniform illumination of an intensity recognized as sufficient for work to be carried on. Light in its relation to production was considered solely from the standpoint of a substitute for waning daylight. But it is characteristic of engineering development that study and analysis continued until it was definitely shown that the amount or degree of illumination was a vital factor in increasing production in all kinds of work. No longer was it a question of determining whether the light satisfied the average investigator or the average workman as being enough to enable him to "see his work all right." Rather were definite data gathered to show that as intensity increased so did production.

As a specific example, in tests recently conducted at the Columbus plant of the Timken Roller Bearing Co., the employees were not consulted and their reaction to the various levels of illumination provided showed up in the daily production record. There was no demand for better lighting on their part, but the higher standards of the order of 15 to 20 foot-candles were provided for the test purely in an effort to establish what relationship, if any, exists between illumination and production. The test data showed that the curve for production during any period followed closely the curve of the illumination intensity, increasing as the illumination was increased and falling off when the illumination was lowered.

The engineer does not yet know to what intensity it is desirable to go. It is known that on changing from 3 to 4 foot-candles to 15 or 20 or 30 foot-candles, there is a definite increase in productivity. Some experiments indicate that 50 foot-candles is not too high, and some able and experienced engineers talk in hundreds.

Enough, however, is now known on the subject to cause many manufacturing executives to realize that illumination does play a real part in the productive effectiveness of their plants. They can see that by increasing the expenditure for light by three, or four, or six times, they have to increase only one of the very small elements of their manufacturing costs and that the returns on this expenditure is manyfold. Thus in the case of the Timken plant previously referred to, it was shown that when 20 foot-candles were provided the increased cost of lighting over the original 5 foot-candle lighting system amounted to about 28 cents per hour, the 12½ per cent increase in production obtained meant a saving of $1.44 per hour in labor.

From the standpoint of the illuminating engineer the problem of lighting thus presents many new aspects. He is no longer merely a calculator of illumination intensities. He has to consider his contribution to the producing ability of the plant, and the actual illumination studies he makes are complicated by the intru-

sion of glare and similar problems on account of the intensities used. Requirement and opportunity exist for a great deal of illuminating engineering ability in the successful application of this newly developed philosophy of industrial illumination. Only a small part of industry has so far reaped the benefits, but from now on surely no engineer charged with the layout of a factory, and no engineer charged with the problem of lighting it, can fail to consider fully the relation of illumination to that factory's production.

What I have just said follows closely the Electrical World editorial. This seems to state the current problems in lighting for the industrial field and the same idea might well be carried over into the other two main fields, the commercial and residential. From the standpoint of the illuminating engineer, the present-day problem of illumination has taken a new turn, an upswing on a new cycle of progress.

Through all the ages little progress was made in the science of lighting, its history being merely a record of various illuminants from olive oil to kerosene. There was need for more light and the electrical business got away successfully because the lamps gave a stronger light. There was a time when the big thing in electric lighting was the light source itself when progress in lighting was reported entirely by new developments in lamps and lamp efficiency. But this period halted about 1913, with the advent of the gas-filled Mazda C lamp, because since that time no new or revolutionary light sources have appeared. The carbon lamp with its many improvements, the Gem, the tantalum, the pressed tungsten, the drawn wire filament Mazda lamp, and, finally, the gas-filled lamp are fairly definite stages in the development of the incandescent lamp. The result is that the lamp is good.

Then along about 1910 lighting engineers began to think about the best application of the incandescent lamp. With the introduction of these gas-filled lamps it became apparent that we had suddenly broadened our knowledge of light sources far beyond any commercial appreciation of them. Even though our stores and factories were demanding more light, the substitution of these high powered lamps for previous types instead of bettering visual conditions actually hindered and made vision more difficult. The past ten years have given us equipment which embodies ten years of engineering effort with metal, and glass, and physics of light as ingredients to change raw light into good illumination. Their studies during that time have been qualitative. They have turned their attention from the lamps to the service they render with the result that a cross-section of illumination shows that there are a number of factors, such as glare, reflected glare, shadows, color quality, as well as the actual amount of light enter into the question of proper illumination.

We know enough about lighting fundamentals now to analyze the requirements of any operation and to prescribe lighting which will be satisfactory and illuminating engineers have so simplified

this task that it is no longer a problem for the engineer, but, in the majority of cases, can be solved by the least experienced. What used to be a tedious, all-day task in computing illumination results has become a matter of a few minutes reference to standard data.

Certain standards of illumination have been specified for various classes of service and just now illuminating engineers are asking themselves, "are these present standards efficient?" The answer to this question involves many things. It involves the theories of vision, physical and psychological reactions to light, and many other things of a scientific nature. These studies have carried far beyond the material things, beyond the lamp and the reflector, to a study of human reactions to light under various circumstances.

So today, we talk of illumination in its relation to production and to the health and welfare of the workers which are so intimately tied in with industrial operation; we refer to store lighting or show window lighting not in terms of lamps, reflectors, wire or sockets, essentially, but in terms of its sales-producing value to the merchant or its attracting power in compelling attention to merchandise which are prime functions of commercial establishments. In homes, we are applying light not merely as a substitute for daylight, but, in addition to pure utilitarian needs, as an agency to promote comfort, convenience, and decoration—to improve the home esthetically—or, as a definite example, light has made a basement out of a potato cellar.

As an example of this new philosophy of light let me cite a few practical instances. The United States Postoffice Department is in the process of relighting the postoffices all over the country. Did they undertake this because of late revolutionary developments of lamps or new illuminants? Did some manufacturer of lighting equipment sell them the idea by virtue of some new type of reflector that was claimed to double the efficiency of the lighting system at half the cost? Not at all. Lamps and reflectors were a secondary consideration. This department is the largest of all government agencies in point of personnel, and has a real problem of maintaining the health and efficiency of its employees. Their studies and decisions were based on special governmental investigations: (1) that employees of a postoffice working under 2 or 3 foot-candles had less normal vision and more eye defects than employees in another office working under 3 or 4 foot-candles, and (2) in speed and accuracy tests, letter separators increased their speed 4.4 per cent when the illumination was raised from 3.6 to 8 foot-candles.

Within the last few years we have read reports of dozens of tests which show the relation of illumination to production, to accidents, to industrial spoilage, to sales in stores, etc. A few months ago we read in Factory an article by Mr. Magee, president of the Detroit Piston Ring Company, entitled, "How Better Illumination Increased Our Production 25 Per Cent." A paper before the Illuminating Engineers Society at their September convention showed that in the inspection department of the Timken Roller

Bearing Company, a 12½ per cent gain in production was obtained with increased illumination at an increase in cost amounting only to 2½ per cent of the payroll. A recent test in a Chicago department store showed that when their lighting system was alternated to produce 5 to 15 foot-candles that sales fluctuated likewise and the net result after several weeks test showed a 29 per cent increase in store sales in favor of modern lighting. Many more such cases could be cited, however, I did not set out to convince you of the value of good lighting, but merely wanted to show that the thought on lighting had gone beyond the material things which make up a lighting system—the lamps, wire, switches, and reflectors, and methods which are already good—to a more complete understanding of the good that proper illumination will do.

I would sum it all up by saying that at present the lighting engineer's big job now, in the three major fields, is the dissemination of his knoweldge to the public in a way which will be effective in narrowing the spread between lighting conditions common today and what they would be if advantage were taken of the most effective use of our electric lighting service.

There are several hundred thousand plants in the United States and it is estimated that less than 40 per cent have what might be called good lighting. There are about one and one-half million stores in the United States and it is fairly definitely established that only about 30 per cent of these have good lighting. In home lighting, although we know that, conservatively speaking, the average home might well double its average kilowatt consumption to get the greatest yield on its electrical lighting service the possibilities of light as a decorative medium are so unlimited that it is difficult to predict the market in this field.

We have good lamps, we have good reflecting equipment, we can produce good illumination, and illuminating engineering has turned from these things which formerly occupied all their time, to engineering facts which outline the limits of progress with materials at hand.

As I said before, there is a wide divergence between principle and practice in lighting and the business of making these two coincide is largely educational and commercial. Lighting always has been the backbone of the electrical industry. It has been the impelling motive in the introduction of electrical service into every community that now enjoys it. In view of the new thoughts on lighting we have a market that is capable of expanding in two dimensions. No longer need the central station, the electiral jobber, contractor or dealer look solely to virgin fields for more business, but there is a tremendous market for better lighting all around him among his present customers.

Lighting comprises 25 per cent of the central station's load and returns about 60 per cent of the revenue. It makes up 66 per cent of the jobbers' sales and 68 per cent of the dealers' sales; and there

is an opportunity to double the present volume, if properly promoted.

The lighting business—the job of merchandizing illumination—is different from the merchandizing of most other commodities because light itself is so intangible. There is little romance or pride of possession in the materials, the wire, switches, sockets, or lamps, which make up a lighting system, consequently lighting sales must be made primarily on a basis of better visual conditions which, perhaps, the prospect has never experienced or, at least, has never definitely associated as a definite lighting aid. In selling automobiles, tractors, electric fans, or flatirons, though an appeal must be made on the basis of pride of possession, service, comfort, or convenience, the sales points are usually as obvious to the prospect as to the salesman.

Illumination, on the other hand, is more subtle in its effects, and unlike an automobile engine which develops a knock or refuses to run when something is amiss and thus directs attention immediately to its troubles, a lighting system with many faults and shortcomings manifests no such obvious symptoms, and will be retained in service without alteration simply because the public has not yet come to comprehend illumination either quantitatively or qualitatively. In general, they have learned to demand only the simplest requirements and to apply illumination only for the most elementary uses.

The development of the lighting business is largely in the hands of the central stations, engineers, and educators, who are in a position to go out and apply our advanced knowledge of lighting in a practical way in their own communities.

ENGINEERING FEATURES IN MINE DEVELOPMENT

CECIL W. SMITH
Chief Engineer, Illinois Coal Corporation

The subject of engineering features of mine development, is a question which is not only of particular interest to the mining engineer, but of general interest to all branches of the engineering profession. Mining engineering is little more than a combination of civil, electrical, mechanical and chemical engineering. In opening up new mine property there are questions which are of interest to the members of all of these professions.

Taking up an individual coal mine and the problems which arise in their logical order, the first step is to acquire the mining property, particularly the mineral rights. The coal and mineral rights are usually acquired by obtaining options from the individual owners. This is especially true in Illinois. The farm lands were disposed of by the government without any idea of any coal or minerals being present beneath the surface. The persons who obtained the surface from the government obtained title to every-

thing so the minerals, coal in particular are in the hands of the individual property owners.

After the options have been obtained covering a continuous area, the next step is to drill and ascertain if the coal is present and if present, if it is of the quality and thickness to enable profitable mining. This drilling is done with diamond drills, similar to the ones used in the prospecting for foundations. By systematic drilling the exact strata and the thickness of the coal are revealed and a sample of the coal itself is brought to the surface, in order that it may be analysed by a chemist. After the drilling is well started and a number of holes have been put down, it is then advisable to make a survey of the coal land to be drilled, and determine the contours on the coal. This will reveal the general lay of the coal seam, whether it is level or whether there are any difficult grades or inequalities which would serve to hamper the operation of the mine.

When the field has been completely surveyed and drilled this map should show with considerable accuracy the contours on the coal seam, and from this map can then be determined the desirable location of the shafts for the mine. The shafts should be located so that it will not be necessary to pull coal up hill. This shaft location also involves the problem of drainage. In the deeper coal mines of Illinois, drainage is a comparatively small factor. The strata overlying the coal usually consist of shale, which is more or less impervious to water, so the water therefore does not get into the mine, except through surface breaks. The shafts should be located, however, so that if there is a possibility of surface breaks occurring and water entering the mine, it can be handled by natural drainage as far as possible.

After the drilling is completed and if the existence of coal in workable thickness and the desired quality has been determined, the coal and mineral rights are usually purchased under the options and the sinking of the mine can begin.

The first problem in planning the mine is the railroad connections. The transportation of coal from the mine to the market has to be arranged and mines are usually sunk near some trunk line road. The railroad connections must be surveyed and constructed so that materials can be brought in for the sinking of the shafts and the construction of the mine buildings. The next problem is location of the mining plant. The location of the mining plant depends on two things, first, the lay of the coal underground and the mining conditions, and second, the contour of the surface. It usually is not possible to get ideal conditions both on the surface and underground when the question is considered from both view points, and it is usually necessary to make a compromise. Some certain advantages in the underground conditions must be sacrificed to obtain certain advantages in surface conditions.

The most important consideration in the construction of the mining plant is the proper design of the loading tracks, for hand-

ling the railroad cars. It is desirable to handle these cars as much as possible by gravity alone. The empty cars should be set upon tracks of high elevation and should be let down to the loading tipple by gravity. From the loading tipple the cars should move by gravity to the yards for loaded cars and from there be taken by the railroad company. This is desirable because it saves labor and delays caused by the necessity of having locomotives switch the cars.

Another consideration which has a great effect upon the design of the mining plant is the power to be used, whether it is to be central station power or whether it is to be generated at the mine. This choice depends to a large extent upon the availability of central station power and the power rates. It also depends upon the type of equipment which will be installed in the coal mine. The depth of the mine and the tonnage to be hoisted also affects largely the choice of the power source.

The building locations must be carefully considered in designing the mine plant and every factor in increasing the efficiency of operation and the comfort of the employees should be studied. The drainage of the surface plant should be given careful consideration, so that water will not accumulate around the property during rainy seasons.

In connection with the sinking of most large mines the housing of the men and the laying out of towns for the accommodation of these men, is an important problem. The first mines in this state were sunk near existing towns. This was the logical thing to do and involved no expenditure for houses or other facilities, but now on account of the intensive development of the coal lands in the good producing districts, mines are being sunk farther and farther away from exisiting towns. The question of housing the men is important because the miner is a drifter. He will work in one mine this week and next week will pass on to another. He circulates from mine to mine and in times of good work chooses the mine which is most convenient, and where working conditions are the best. The result is that when mines are working good and coal production is wanted, the mines further from desirable towns suffer a shortage of labor, while the mines in town may have surplus. For this reason the housing question is very important. A well laid out town near a mine and one which furnishes the men a good place to live with modern conveniences insures a good labor supply. Mining towns should be laid out attractively and along the lines of scientific town planning, the same as the subdivision of any city, but care must be taken that they are not "dolled up" too much or made too attractive. It has been the experience in several projects where landscaping of lots has been done, sidewalks, pavements and water systems installed that the cost of lots is increased to such an extent that the miners will not pay the cost for these improvements. In many such cases the miners have bought property adjacent which was little more than a corn field with lots

and blocks marked off, merely because the price was less and because unnecessary improvements were put in.

After completion of the railroad connection the first operation in the construction of the mining plant, is the sinking of the shafts. This is a slow process. Hoisting of men, material and spoil is done with either a steam or an electrical hoist, depending upon the availability to central station power. In most cases the use of central station power is advisable during sinking because it involves the purchase of a minimum amount of equipment. The speed of shaft sinking varies, depending on the size of the shaft, the material used for lining, and the strata passed through. An average of from four to six feet a day is usually obtained on the sinking of mine shafts and the placing of the lining.

The building construction is usually carried on simultaneously with the sinking of the shafts. The ideal way is to have the work so scheduled as to have the tipple and buildings completed shortly after coal has been reached in the shafts. This makes it possible to speed up the development work underground and place the merchantable coal on the market.

As soon as the shafts have reached the coal, underground development work is started. This consists of driving the entries for the shaft bottom and opening up working places to enable the production of coal. This is necessarily slow. The first step is to drive an entry connecting the two shafts. In this state, the law requires that every coal mine shall have two shafts or two means of exit and entrance. This is to take care of the possibility of an accident in one of the shafts preventing the miners from coming out from that opening. As soon as the shafts are connected the air can be forced down one shaft and out the other. After the shaft connection has been made, the entries for the mine bottom are opened up in accordance with a pre-determined plan. There is nothing more involved in making up this plan than for any transportation system where a considerable amount of material is to be transported to a certain point and from that point removed. The problem of coal mining is largely one of transportation. It is a bulky material and large quantities must be handled. A mine producing five thousand tons a day, with an ordinary size mine car, makes from one thousand to seventeen hundred hoists a day,—that means one thousand to fourteen hundred mine cars must be brought to the shaft, hoisted, dumped and returned to the working places each day. This plan of the mine is governed more or less by the revelations of the exploratory diamond drilling. Very often it is possible to devise a plan so that a considerable amount of entry work can be driven before it is determined which side of the shaft will be taken for handling loaded mine cars and which side will be used for empties. After the entries are well advanced and rooms can be started, the permanent shaft bottom is constructed and permanent equipment is installed.

When mining in the rooms is started, the mine is usually put

on an operating basis,—that is the development work is stopped to a certain extent and the production of coal started in a large way. In an operating mine, there are really but four major problems to be considered. The first is the ventilation, and this is possibly the most important of the four. The number of men employed underground depends upon the amount of air in circulation. The state law specifically provides there shall be not less than one hundred cubic feet of air per minute for each man, and not less than five hundred cubic feet per minute for each animal underground. It also provides that no more than one hundred men shall be put on one split or separate current of air. A well ventilated mine rarely has an explosion while a poorly ventilated mine is subject to explosions at all times.

The second important problem in mine operation is the transportation, moving the loaded mine cars from the working places to the shaft and on to the surface and bringing the empty cars back again. To insure efficient transportation mine cars and motive power must be kept in proper running condition. The mine tracks must be kept in alignment and must be well cleaned. The entries must be well timbered to avoid the possibility of falls and accidents.

The third problem and the one which in the past has received small consideration is the matter of power and power transmission. High voltage is now permissible in the mines of the state, so there is practically no limit to the extent of underground working, so far as power and power transmission are concerned. The use of alternating current machinery is becoming more and more common in the coal mines, allowing the transmission of large amounts of current at high voltage for considerable distances undergronnd.

The fourth problem in the operation of a mine is the method of working the coal. This is a subject which has not been given much consideration in this state for two reasons, the first is the agreement with the coal miners, which contains conditions making it prohibitive to lay out a modern and advanced system for the working of coal and getting the highest percentage of recovery under the present market conditions. The second reason is that a great many coal mines are being operated in territory where the surface is valuable for farming purposes. If a higher percentage of recovery is obtained, the surface is damaged to a certain extent and lawsuits against the coal mining company follow. The damages are usually awarded in these law suits by the farmer juries and usually exceed the value of the coal that could be taken out by a more advanced system of working. It is unfortunate that these conditions exist. The coal mines in this state are extracting not more than fifty per cent of the available coal, and steps will eventually be taken for the passage of legislation enabling the recovery of a higher percentage of coal. Steps may also be taken requiring the miners to accept working conditions, making the adoption of advanced systems of mining practicable.

This covers in general the engineering features in the development and operation of the coal mines. It is unfortunate that there are not more technical men engaged in the coal industry and particularly in the operating end of the industry. There seems to be a growing demand for technical men which it is impossible to fill. The present mine superintendents and foremen at most coal mines are men who have come up through the ranks and have learned coal mining from actual experience. The industry is, however, becoming so complex and so many new features are being introduced that the demand for technical men far exceeds the supply. Coal mining is an excellent field for any young engineer who is willing to go into the coal mines and enter the actual operating end of the business.

MR. TRACEY. Supt. U. S. Bureau of Mines.

I would like to ask Mr. Smith in connection with the agreement with the miners, just in what particular way they are restricted by that? Isn't that the same agreement we had in western Pennsylvania?

MR. SMITH:----

They have the same general wage agreement but the working conditions are different in the different districts. These are not included in the general agreement but are in the local or district agreements. For instance in most of this state, it is required that the track be laid in the center of the room while in western Pennsylvania they lay the track along one rib.

RELIEF SEWERS

A. W. CONSOER

Material men, contractors, promotion bureaus, and engineers are constantly engaged in promoting the construction of the types of construction in which they are interested. Such efforts to encourage the construction of public works are praiseworthy whenever the benefits equal the cost of the improvement. This is the underlying principle of all special assessment practice.

When we come to consider "Relief Sewers" we approach a subject and a type of construction that promotes itself. Flooded basements and ponded streets create a demand for relief that no conscientious City Council can ignore. During the year 1923 there has been a brisk demand for relief sewers because of several rainstorms of long duration and unusual intensity. Records of the U. S. Weather Bureau for 1923 show that the year 1923 witnessed weather conditions that provided a real test for storm water sewer systems and combined sewer systems in Illinois. Rainfall statistics are never very entertaining, but it is interesting to note that at Chicago on August 11th, 1923, there was a rainfall of 1.95 inches

between 1:00 and 2:00 A. M. This was followed by a drizzling rain lasting until 7:00 A. M. Then between 8:00 and 9:00 P. M. there was precipitation of .47 inches, and from 9:00 to 10:00 P. M., .55 inches with a total for the day of 3.70 inches. This was the greatest rainfall of the month of August since 1871 and is the largest daily precipitation since 1871 on record in the Chicago Weather office with the following exceptions:

August, 1885	6.19 inches
July, 1878	4.14 inches

The records for these last two days, however, show lower hourly rates. Similar rainfall statistics for 1923 are available for Sparta, Paris, and Freeport, showing that rain storms of long duration and unusual intensity were experienced quite generally throughout the State of Illinois during August, 1923.

These conditions overtaxed many existing sewer systems, flooding basements and ponding the streets, alleys, and in some places the sidewalks and lawn spaces. As a result many property owners and municipal officials demanded relief sewers.

The design of a system of relief sewers is usually a more definite problem than the design of a new system.

Sanitary systems are usually over-designed and give little trouble except where they are improperly used; namely, by permitting roof water connections or connections for street inlets. For such conditions the sanitary sewers are easily relieved by removing the improper connections. It is worthy of mention that in the writer's practice it is the exception rather than the rule to find a sanitary system being properly used, particularly in the case of systems constructed several years ago. It is frequently found that in order to cheapen pavement construction, inlets are connected to sanitary sewers. City officials frequently do not realize that their "sewer system" is not intended to carry storm water. Very few towns are found where rigid control is exercised over roof connections to the sewers. As a result, some sanitary systems were overtaxed by the August storms and created a demand for remedial measures. The remedy in such cases is simple: the construction of storm water drains which will intercept such improper connections to the sanitary sewers.

For a number of years just past, sentiment among sanitary engineers has been in favor of the double system of sewers, just as practice when sewers were first built favored the combined system of sewers. Abuse of sanitary systems and more rational methods of storm water sewer design have in the past few years found engineering practice again favoring combined sewer designs. In the writer's practice, very few instances have been found where a double system is cheaper in first cost, particularly if allowance is made in the estimate for the additional cost of double house connection sewers. In such estimates, allowance must be made for higher cost of sewage treatment in case of the combined system.

In the case of combined sewers requiring relief, the problem of design is more complex than in the case of overloaded sanitary sewers. There is one advantage the designer has in the matter of relief sewers which he does not ordinarily have in designing a new system. Relief sewers are usually demanded for built up areas, so that the survey can determine quite accurately the percentage of impervious areas in the various tracts under consideration. The survey should also be a complete inventory of existing sewer facilities with notes on condition of existing sewers, location and size of storm water inlets and connecting pipe. Data on basement elevations and high water conditions at the outlet are often of extreme importance. Sometimes it is desirable, particularly on trunk lines, to make guagings to determine value of 'n' in Kutter's formula, as this is a most important factor in determining the actual capacity of the trunk sewer.

The making of such a survey and investigation is a laborious task and is far more expensive than what is ordinarily necessary in a survey for a new system. But if property owners are to be assessed for relief the engineer must be very sure of the sufficiency of the relief sewers he designs.

The most difficult problem in the design of relief sewers is to analyze properly the rainfall data for the locality in which relief sewers are to be built. Although the government weather bureaus and other agencies have greatly increased the volume and accuracy of rainfall data, we still have only meagre information regarding the extent and distribution of rainfall during heavy storms, and when we come to the matter of length of time required for storm water to reach inlets, there is practically no information in the literature of the subject. Recently some interesting experiments have been made and explained by Frank A. Marston, Member of the American Society of Civil Engineers. These experiments indicate that for the ordinary sewer district a uniform rate of rainfall throughout the district during extreme storms must be provided for in the design of relief sewers. The paper describing these experiments is published in the Proceedings for the American Society of Civil Engineers for January, 1924.

In the writer's practice it has been found that remedying conditions at the outlet of the sewers will frequently effect considerable relief to a sewer system at a small expense. Recently, investigation was made of a combined system where pumps were installed at the outlet to lift the effluent of the outfall sewer from a collecting pit into the outlet stream. Investigation showed that the capacity of the pumps under the most favorable conditions was only one-fourth of the capacity of the outfall sewer. Similarly the capacity of several outfall sewers has been found to be seriously impaired by high water conditions at the outlet. This condition can be remedied frequently by the installation of suitable pumping equipment.

A study of existing basement elevations will frequently permit

the use of a more favorable hydraulic grade line for old sewers in connection with a relief system than would be used on new design, so that data on basement elevations is needed in the design of relief sewers. In one instance a study of basement elevations made it desirable to count on an existing sewer laid on a flat grade to discharge at both termini.

In general the design of relief sewers calls for most careful examination of existing sewers, topography, character of occupation, character of soil, distribution of sidewalk, pavement, and roof areas, rainfall data, high water conditions at outlets, and other features involved in the design. A problem in the design of relief sewers usually provides many opportunities for the exercise of engineering ingenuity, and calls for the expenditure of considerable time and effort on the part of the engineer because in designing relief sewers he is usually dealing with localities where property values are high, and damage from imperfect sewerage is costly and the source of much inconvenience and annoyance. It is a class of engineering work which should be done with painstaking thoroughness and is certainly no field for hasty, rule-of-thumb methods of design.

SEWAGE PLANT OPERATION IN ILLINOIS

A. M. BUSWELL AND G. A. WEINHOLD

In discussing sewage disposal in Illinois we have divided the towns into three groups according to the preliminary treatment which the sewage received. Group I includes 143 towns with sewerage systems discharging directly into streams, Group II includes 59 towns which provide some sort of preliminary treatment in sedimentation tanks and in Group III there are 46 towns having tanks and filter beds.

Illinois, according to the 1920 census, has a population of 6,485,280 people. Of this number 4,551,143 or 70.1 per cent were connected to some sort of a sewerage system. The Chicago Sanitary District provides sewerage for 2,963,040 or 45.7 per cent. In the rest of the state about 1,099,544 or 16.9 per cent are connected to a sewerage system which discharges directly into a water course without treatment, 273,205 or 4.2 per cent have their wastes treated by simply passing them through some form of sedimentation tank to remove solids and then discharge them into a water course; 215,306 or 3.3 per cent have or are about to start more complete treatment works consisting of tanks and filter beds.

Of the 46 towns in Group III having tanks and filters of some sort 22 were selected for the purpose of study. Visits were made to these towns during the last summer and fall. A questionnaire, which was made out after consultation with members of the committee, was used as the basis for collecting data. Samples were also taken at different times of the day at each plant. The settle-

able solids were determined in the field and the suspended solids and oxygen consumed from Km_nO_4 were detrmined on iced and chloformed samples shipped to the laboratory.

The entire report comprises some 70-80 pages and of course cannot be read in full. The following summary together with discussion by other members of the committee will serve to indicate its content.

A total of twenty-two cities were visited, one of which had no sewage disposal facilities of any kind. Of the others a total of 9 Imhoff tanks, and 12 septic tanks were observed. Three cities were building new Imhoff tanks. All new construction planned was for Imhoff tanks. The Imhoff tanks were practically the same, the differences being in the location of the gas vents, some having a vent at the side of the settling chamber and others having one vent between two settling chambers. The gas vent area varied considerably from practically none to 30 per cent of the total tank area. The slopes to slots were practically all 45 degree angles. One plan calls for a 60 degree slope. The newer tanks have facilities for reversing the sewage flow through the tanks but most of the old ones did not. The septic tanks varied considerably due mostly to the placing of the baffles. Some caused a round-the-end movement and some an over-and-under movement. Planks for scum boards were quite generally used. Having the effluent drop a foot or two from the septic tank to dosing chamber to provide aeration seemed a favorite practice. A glaring defect was in allowing too much scum, caused by the bubbling in the septic action, to get into the dosing chambers and on to filters. This was due to lack of final scum board or too infrequent cleaning.

The types of filters used varied considerably. There were four sprinkling filters, four trickling filters, eight intermittent sand filters, one natural gravel filter, one contact bed, one coke filter, and one sewage farm. The sprinkling filters were all in the somewhat larger plants, two being new plants, one under government supervision and one about three years old. They were all receiving fair attention. The main trouble is the lack of knowledge on the part of the operator that the process is biological and failure to use all available filter area and to maintain bacterial flora on stones. The trickling filters were all somewhat over loaded and received too little attention. The same trouble was evident with respect to lack of knowledge regarding the process. Several places alternated the filters in use at infrequent intervals and had no automatic dosing apparatus. Most sprinkling and trickling filters if alternated correctly and given better supervision would adequately take care of the load. In some places the errors are due to instructions on operation given by the builders of the plants who advise that operation is mostly automatic.

The intermittent sand filters seem the best adapted to small towns. At least they were in the best condition. This is perhaps due to the fact that unless looked after they are the quickest to

become unsightly. Therefore most of the towns had men in charge daily to take care of the plants. There was one sewage farm in good condition, one coke filter and one contact filter which were both run down. One natural filter the efficiency of which could not well be ascertained.

There were ten places that had tile drained sludge drying beds. Others flushed the sludge away into water courses at times of high water.

Methods of distribution varied considerable. Some used wooden troughs, others concrete and others tile, both whole and half. Some had many side troughs and others just two or three main ones. Many had a large percentage of beds covered by the distributing system. This was especially true of trickling filters. It seemed that the method of distribution was not so important as the evenness of the filter (especially sand). If a little gravel was in place to prevent streaming, the dose automatically seeks its level.

Of the plants visited six could be said to be in good condition and given good attention. Five were fair with regard to condition and seven were poorly attended or had no maintainance at all. Three plants were not yet in operation. Seven plants had a man all day long everyday in the week, two had a man three days a week and three hours a day respectively, six were under the Sup't. of Water or Sewers or received periodic visits. Four received no attention. Of the last, three had no filters.

The cooperation received during the visits was of the best and officials seem eager to become acquainted with their problems.

The following is a summary of that part of the report dealing with the sludge disposal and sludge capacity of the plants visited:

Arlington Heights. (pop. 2700)

Sedimentation tanks are cleaned out every spring after being out of use all winter, so there was no sludge in bottom when visited, (June 28, 1923). Sludge from tank not used. Both tanks had a two foot almost solid scum of sludge on the surface which was black and sticky.

Woodstock. (pop. 5500)

Bubbling in septic tank caused much sludge to come up and pass under outlet baffle to be carried into dosing chamber. Dosing chamber became sludge clogged requiring cleaning every 10 days. The amount of sludge not recorded; hauled away by farmers for fertilizer. Tanks last cleaned in spring 1922.

Harvard. (pop. 3294)

Scum on surface of tanks 30 inches thick at inlet; 18 inches at outlet. Sludge scraped from surface of tank daily between inlet and first baffle—about two wheel-barrow loads. Sludge dumped in lagoon in rear of tanks. Tanks cleaned in May 1922. Little had accumulated up to date of vsit (June 1923) in bottom of tank.

Glen Ellyn. (pop. 2851)

Scum on tanks 2 feet thick at some points on surface; black

and sticky. Tanks drawn and cleaned in fall of 1922. Amount of sludge unknown. Sludge dried and buried.

De Kalb. (pop. 7871)

Sludge bed not in use and no sludge drawn for months.

Sandwich. (pop. 2409)

Sludge vitallic, black and like a thick mud for depth of about 6 feet. Sludge drawn about every 3 weeks to depth of 5 feet; capacity of each hopper 31 cubic yards. Sludge bed size 20 feet by 30 feet by 1 foot; capacity 4500 gallons. Sludge hauled for use as fertilizer.

Downers Grove. (pop.5000)

Sludge chamber capacity, 10,000 cubic feet or 2 feet per capita at maximum flow. Depth of sludge 2 to 3 feet in bottom; last drawn July, 1923. Amount drawn about 9000 gallons; gravity sludge drainage to bed, size 50 by 25 feet overlaid with 12 inches of sand. Dried sludge used as fertilizer.

Sparta. (pop. 3340)

Sludge chamber capacity 2850 cubic feet. Last drawn May 1923; amount drawn 1600 cubic feet. Drying bed 40 feet by 40 feet.

Greenville. (pop. 3092)

Scum one foot thick on tank at inlet; very little at outlet; little sludge in bottom. Drawn in May 1923; amount drawn 29,000 gallons, and drained to ravine.

Chicago Heights. (pop. 19653)

Sludge tank capacity 90,000 gallons; depth 5 feet. Drawn July 1923; amount about 35,000 gallons. Drying bed about 100 feet by 50 feet with 1 foot of sand.

Fort Sheridan. (pop. 4000)

Four sludge beds, each 24 by 38 feet with sand underdrain. Drawn July 4, 1923; number 4 yielded 10 cubic yards and number 3 yielded 8 cubic yards wet sludge. No surface scum on tanks.

Olney. (pop. 6000)

Sludge capacity; 100 days. Last drawn April 1923. Amount drawn about 13,000 gallons. Sludge drying bed size 30 by 30 feet with 2 feet depth of sand.

Fairfield. (pop. 3000)

Plant apparently inoperative through obsolescence and neglect.

Johnston City.

New plant and operation began at time of inspection.

Christopher. (pop. 3830)

Little scum on tanks. Sludge capacity 8000 cubic feet. Depth of sludge August 1923 six feet. Last drawn April 1923, which was first time in 8 years. Amount of sludge not measured; wasted in creek.

Aledo. (pop. 2231)

Depth of sludge 6 to 12 inches; last drawn 2 weeks before in-

spection. Amount of sludge not measured. Drying bed 50 by 35 feet by 16 inches deep—12 inches of stone and 4 inches of sand. Drainage of bed not efficient.

Galva. (pop. 3000)

Two plants, (1) north side and (2) south side.

(1) North side. Sludge capacity about 45,000 gallons, below slots. Depth at time of inspection 6 inches. Last drawn not known. Sludge drying bed 30 by 30 by 2½ feet. Drainage of bed effective.

(2) South side. Depth of sludge variable. Last drawn about March 1923. Amount not measured.

Princeton. (pop. 4126)

Depth of sludge 6 to 12 inches on bottom. Last drawn September, 1923. Amount not measured. No sludge drying beds. Wasted to creek.

Mendota. (pop. 3934)

At sewage farm about 3 inches of sludge on bed when dried. Bed consists of sand 20 inches deep, underdrained by tile.

At Imhoff plant, sludge compartment 11 feet deep below slots and about 33 by 59 feet. Removal effected through 8-inch pipe into creek, or to drying bed 30 feet by 22 feet 6 inches by 14 inches deep of medium gravel.

RECOMMENDATIONS

1. Broad, popular, educational publicity through all available agencies, same to be fostered by various State Bureaus, Engineering Societies, the American Society for Municipal Improvements, the American Public Health Association and American Water Works Association. Co-ordination of this publicity effort is advisable and necessary to avoid duplication and contradiction.

2. Standardization of the devices employed in sanitary engineering works at least as far as the principles underlying the design of treatment and disposal works.

3. Encouragment of record keeping by officials charged with the operation of sewage works.

4. State inspection of sanitary engineering works, under one of the bureaus of the state, at regular intervals, similar in procedure to that in vogue by the State Fire Marshal or Factory Inspector; including publication of reports to secure results in local newspapers, when other agencies fail to effect sanitary operation of works.

SEWAGE PROBLEM OF THE SANITARY DISTRICT OF CHICAGO

LANGDON PEARSE

In the thirty-four years since its organization, the Sanitary District of Chicago has built the Main Drainage Channel from the Chicago River to Lockport, which reverses the flow of the Chicago

River, and also the two collateral channels, the North Shore and the Calumet. As a result, the sewage has been removed from the entire lake shore of Cook County, some thirty-four miles long. The Chicago River has also been widened and straightened and obstructions removed, and new bridges built, so as to make a channel with a minimum width of 200 feet between dock lines. Further, a power house has been built at Lockport on a fall of thirty-four feet to recover the power running to waste, whereby electrical power is generated to light the streets and parks of Chicago, run the sewage pumping stations and treatment works and other municipal utilities. This power is a by-product solely, as the primary object of the Main Channel was the reversal of the Chicago River and the disposal of the sewage of the Sanitary District by dilution.

The charter of the District provides for the dilution of the sewage with a minimum ratio of three and one-third cubic feet per second per 1000 people. On this basis, the capacity of the channel, namely: 10,000 cubic feet per second, would care for 3,000,000 people. At the present time, the population is in excess of 3,000,000. Further, owing to the steady growth of Chicago and its suburbs, in amount some 700,000 every ten years, and to the additional load produced by the big packing house industry and the Corn Products Refining Company factory at Argo, an additional load equal to over 1,500,000 people has been placed upon the main channel over and above wastes of human origin. As a result, the capacity of the channel for dilution has been exhaused.

The trustees of the Sanitary District have long recognzed the need of supplemental methods of treatment to reduce the load upon the channel. Experimental work was begun in 1909 upon domestic sewage. This was later expanded to cover a comprehensive survey and experiments on the wastes from Packingtown, corn products at Argo, and the tannery industry. About three years ago the Enabling Act of the Sanitary District was amended by the Legislature, making it mandatory upon the Sanitary District to construct sewage treatment works and put them in operation, begining with 1925, annually at the rate of 325,000 persons per year, until 60 per cent of the then population was cared for, or approximately 1,800,000 people. However, in later negotiations subsequently conducted with the Chief of Engineers of the U. S. Army, a wider program of treatment was offered which would comprise the treatment of approximately 4,250,000 in 1945, with a program contemplating the expenditure of not less than $25,000,000 in every five year period. Under the program offered, at least 1,290,000 would be treated in 1928.

In carrying out the program, the Board of Trustees has been worried by one discordant feature; that is, the amount of diversion from the lake. The canal was planned for a diversion of 10,000 second feet. However, at the start a permit was issued to the Sanitary District by the Secretary of War for a flow of 4167 c. f. s., a figure based solely upon the navigable velocities in the Chicago

River, then a narrow, crooked stream. Since the opening of the canal, the Sanitary District has spent upwards of $16,000,000 in widening and straightening the Chicago River and removing the obstructions. Believing that this improvement in aid of navigation warranted an increase in the diversion, demands have been made from time to time to secure an increase in the permit from the Secretary of War, but without success. However, in order to comply with the requirements of the state law under which the District operates, the flow has been increased, so that at the present time about 8500 c. f. s. are flowed. In 1908 a friendly suit was started to determine the rights of the Secretary of War in connection with the construction of the Calumet-Sag channel, which suit was later widened into injunction proceedings to determine the legality of the entire diversion. This suit was originally heard by Judge Landis, and upon his resignation from the bench was turned over to Judge Carpenter. Judge Carpenter recently rendered a decision enjoining the District from taking more than 4167 c. f. s., but the effect and operation of the injunction has been stayed by supersedeas during the pending of the appeal to and until the final decision of the Supreme Court of the United States. Meanwhile, as a solution of the entire controversy, Senator Medill McCormick of Illinois has introduced a bill in the Senate which creates a nine-foot waterway in the Illinois River and Mississippi River to Cairo, and further would legalize the diversion of 10,000 c. f. s. from Lake Michigan. The bill further provides for the control of the level of the Great Lakes by regulating works at the outlet of Lake Erie and Lake Ontario, which works would be built at the expense of the Sanitary District, and further for the construction of supplemental sewage treatment works, so as to reduce the load in twenty-five years to one-half the present load of human population upon the main channel. This is equivalent to treating the sewage of 4,250,000 people by 1945.

The agitation against the diversion of 10,000 second feet is largely based upon the false premise that more water is diverted from Lake Michigan than should be permitted to serve the best interests of navigation and of the port cities around the Great Lakes. The facts indicate that the lake levels are constantly fluctuating in accordance with the laws of nature. Daily and seasonal fluctuations are of far greater moment than any lowering of level ascribed to the Sanitary District diversion.

Reducing the diversion will not cure the difficulties which are claimed to occur. The only correct solution on the lake level problem is the regulation of the outflow to hold back the excess water in the spring until fall. The Sanitary District believes that this can be done for around $2,500,000, and has offered to pay whatever the works will cost.

The sewage treatment program upon which the Sanitary District is now actively engaged is based upon a diversion of 10,000 c. f. s. This will require an expenditure of about $100,000,000. If

the diversion is cut to 4167 c. f. s., an additional expenditure of over $25,000,000 is needed for sewage treatment, and upwards of $100,000,000 for water filtration. Thus an additional expenditure of $125,000,000 will be entailed, which will not help the lake level problem materially, whereas the expenditure of only $2,500,000 in regulating works would do real service and permit the lake levels to be effectively controlled.

During all the discussoin and litigation, the Sanitary District has been steadily engaged upon the problem of sewage treatment. The condition of the Illinois River demanded relief. In the sewage treatment program since 1909, two distinct lines of investigation have been followed—one on domestic sewage, the other on industrial wastes. As the engineering studies developed, the division of the Sanitary District into seven major projects became evident together with a number of isolated plants for outlying villages where intercepting sewers would be too expensive at present. Of the projects outlined, Morton Grove, Des Plaines, and Calumet have been built and are in operation. The work on the North Side project is actively under way, the first contract having been let on August 9, 1923, for approximately $5,600,000, for a portion of the activated sludge plant, to successfully handle 800,000 people.

In the operation of the three treatment works, the sewage of over 156,000 people is being actually handled on a working basis. The activated sludge and sprinkling filter plants produce a high grade effluent in which fish can live, which requires no dilution. In addition to the activated sludge process, material is being recovered which is actually taken and used for fertilizer by various agriculturists. This material contains about 5 per cent of nitrogen on a dry basis and from 2 to 4 per cent of phosphate. Growing tests made during the past season indicate that this material is successful with many crops, such as beans, corn, sugar beets, and gladioli. Park boards are trying the sludge on lawns. However, extended tests over many seasons will be required in order to demonstrate the true value of this fertilizer, in comparison with other standard materials. The net result, however, has been an advance in the sludge problem, because heretofore until the activated sludge process was developed the sludge had such a low nitrogen content that it was movable with difficulty and was usually dumped. Experiments are still being conducted on the mechanics of dewatering the sludge to determine the best way of removing the solids. In this work a number of types of filter presses have been tried upon which extended data will be available when the time comes to determine the method of handling on a large scale. At present about two tons of dried activated sludge are being produced daily, for all of which there has been a market. The best price obtained was $9 per ton f. o. b. cars in bags.

In the control of the plants, a staff of chemists and sanitary en-

gineers are engaged, so that from the mass of data accumulated each new plant can be improved.

To sum up, therefore, at the present time, the Sanitary District of Chicago is working upon two programs—one legislative, the other constructive, with a view to clearing up the whole controversy which has raged for over twenty years. In this program, it is hoped to provide for the utilization of the existing capacity in the channel already built by a diversion of 10,000 c. f. s. The lake level problem will be controlled and solved by the regulating Works. The condition of the Illinois River will be wonderfully improved by the construction of sewage treatment works on a scale which is practically unprecedented. By this program, it would seem possible to harmonize all the conflicting interests and secure a constructive development which will be helpful, not only to the Illinois River, but to the entire basin of the Great Lakes.

Many of our citizens have supposed that the main drainage channel solved forever the problem of the treatment of the sewage from the Sanitary District, but the old main channel is a machine, and, like any other machine, has a very definite capacity for work. This capacity was exhausted several years ago, necessitating the construction of supplemental works. From the standpoint of the future, regardless of the outcome of the present discussions, so long as Chicago continues to grow, there will be a sewage problem before it, necessitating every ten years the completion of additional facilities larger than are now required for a city of the size of Baltimore or Milwaukee alone. Such is the problem before the Board of Trustees of the Sanitary District and the people of the Sanitary District.

BEARDSTOWN AND THE FLOOD OF 1922

A. D. Millard

The Illinois River flood of 1922 exceeded in elevation the highest water ever known on the Illinois River prior to 1922; which is to say the high water of 1844, by 2.5 feet. I shall not take the time to describe to you minutely the hysteria which was the feeling of a great many of our people during this flood, beyond saying that I personally was approached no less than three times by delegations asking me to dynamite levees, the LaGrange Locks and other things of similar character. I am frank to say that while I knew such measures of destruction would not add to our relief I presume I was for a moment in about the most unenviable position in which a man might well find himself. I have had the good fortune to view from the *outside* two prisons, one at Leavenworth, Kansas, and the other at Joliet, Illinois. I have absolutely no desire whatever to be on the inside looking out. I therefore, as tactfully as I could, calmed the fears of these excited ones by such arguments as came to me at the moment.

The City of Beardstown asked our firm to make such tentative

plans as might be needed to advise the Legislative Committee as to what in our opinion was needed to protect our town from further disaster. I will now go ahead and describe as briefly as I can, what in our opinion is required to protect our town at a reasonable cost and in a practicable fashion. As you all know a very large proportion of the Illinois River Valley is already behind levees. In fact from Beardstown to the mouth of the river practically the entire river is leveed. On the east side of the river where Beardstown is located there is a levee north of us, that of the Lost Creek Drainage & Levee District, and south of us is a levee, that of the South Beardstown Drainage & Levee District. From the city limits of Beardstown to the South Beardstown Levee is a distance of approximately 3600 feet. On the north or east side of the city the city limits are practically those of the levee of Lost Creek. It occurred to us therefore that the practical and feasible thing to do was to build an earth levee from the South Beardstown Levee up to the city limits, and from that point to the Burlington R. R. which is about three-fourths of the way across the town, to construct a sea wall of concrete for approximately 4000 feet, the general design of which would be similar to that now protecting the city of Cairo, Illinois.

From the Burlington R. R. up to the Lost Creek Levee an earth work levee should be constructed. We also advised that a portion of the South Beardstown Levee lying south and west of the city be strengthened so that assuming that the River Levee of the last mentioned District was to break, the city would still be protected by this levee which lies to the south and west of town. It has so happened that the District itself has already strengthened this levee so that that expense is largely taken care of. The Lost Creek levee can be strengthened and extended at a comparatively small expense, and this in brief sets out our levee plan.

In discussing the merits or demerits of the proposition hereinbefore set forth, we will say that in the great flood of 1922 neither the Lost Creek nor the South Beardstown levee failed. It is true that the Lost Creek District was flooded but this was due to the fact that the water came in from the south and west of the Burlington Railroad and passed through the City of Beardstown from the west. This would, of course, under the scheme we propose, be entirely eliminated. Another advantage of our proposition is this—that by tying on to existing work we will leave Beardstown free to grow in every direction, except toward the Illinois River. It is true that other schemes of improvement are possible, among them would be that of leaving a part of the northeast part of Beardstown outside the levee, and then raise what is known as the Petersburg road for a distance of from two to two and one-half miles. Also by coming down the west side of the city and running south of the levee to high ground for a distance of some two and one-half miles. Both of these propositions however in our opinion, would be decidedly more expensive, and would as a matter of fact

afford less protection to the city than would be effected were our proposition adopted; for the reason that the levee on the west practically would be exposed for a length of fully two miles and a width of three-fourths of a mile to the destructive effects of southwest winds; which are the prevailing winds at the season of the year when our floods usually occur. Under the proposal as we have outlined it there would be about three-fourths of a mile of levee exposed, but with the sweep of water of somewhat less than one-third of a mile, this would certainly be easier to fight than would the other condition I have described.

During the 1923 session of the State Legislature there was appropriated the sum of $350,000 for the purpose of constructing levees around the City of Beardstown. The appropriation bill became a law on July 7, 1923. For reasons best known to itself the Division of Waterways, although this appropriation has been available for the past six months, has not as yet started any survey, to locate or estimate definitely the work which it proposes to do. I am unable to tell you what the ultimate scope of the work will be. As we understand it, however, although we do not say that this will be the fact when thorough study has been made, it is the idea of the Division of Waterways only to come south along the west side of our town about one-half a mile and then turn directly east along the south city limits and go approximately to the Burlington Railroad and as much further east as necessary, which we believe, on investigation, will probably be at least three-fourths of a mile further to ground high enough on which to tie a levee.

As I understand it the State does not wish to set a precedent of appropriating money to reclaim farm lands. It is true that the works as outlined by us will have the effect of putting behind a levee of about 1200 acres of land which are now, more or less, subject to overflow. Putting this land behind this levee would not in any sense reclaim it for the reason that it consists of sloughs, bayous and swamp land, generally, and were it to be reclaimed for agricultural purposes it would have to be ditched and a pumping station built to reclaim it since the sloughs are not dry even at low water. We can readily understand the position of the State in this matter, and we say frankly in that regard that their position is entirely correct; but as an engineering proposition it is hardly feasible to rob Peter in order to pay Paul; and this, in our view, would be the effect of substituting possibly two and one-half miles of levee where three-fourths of a mile would do the work.

Permit me to say that in addition to the work which the State will undertake, the City of Beardstown itself will have to re-construct the sewerage system of the town by building an intercepting sewer cutting off the sewers now discharging into the Illinois River and conduct them by this intercepting sewer to a point west of the town and there discharge them by means of centrifugal pumps in times of flood stages on the River. The sewer will discharge by gravity as now in times of low water. This intercepting sewer and

pump station will burden the town with an expense of approximately $80,000. This expense the town proposes to undertake whenever it is protected against flood waters by the works of the State of Illinois, and until such time as these protecting works are definitely planned and located, it is impossible for the town to design in detail such intercepting sewer works and pumping stations as will be necessary. I realize however in connection with the remarks just preceeding that this is no time for recriminations and what has just been said about the Division of Waterways is not intended as such but it is said in the hope that it may arouse this Division to immediate action. To us, time is a vital element because as an engineer, I will venture to assert that were surveys to be started to-morrow, the contract could not be let within one year from that date for the reason that a large part of this work will require careful study and surveys. You are also all well aware of the many exasperating delays which occur in any improvement work because of questions of acquiring rights of way on which to do the work.

What Beardstown wants, and what Beardstown is entitled to, is protection from conditions which she has no power to control, and which have been brought about by acts of the State and Federal Government beyond any question. As you know, for many years the people in the Illinois River Valley have been at logger-heads with the Sanitary District of Chicago. In fact the people generally in the Illinois River Valley, whether justly or not, think that the Sanitary District of Chicago has not given them a square deal. That is a proposition which I will not discuss at this time, beyond saying that in my opinion it is a question with many angles. That sanitation is vital to a city of between three or four millions is so obvious that it needs no demonstration. That the Illinois River Valley has the right to live, and incidentially that part of it called Beardstown, is also vital to the welfare of the City of Chicago is likewise true for the reason that when there is no tributary territory a city such as Chicago would cease to exist because there would be no economic necessity for it. There is now, as you know, in Congress what is known as a Deep Water Way Bill by which it is proposed to legalize a flow of 10,000 second feet of water through the Sanitary Canal. As a matter of fact we have been getting this water for some years under a revocable permit of the War Department authorities.

Not entering into the question of whether this 10,000 second feet is vital to the City of Chicago nor into the question as to how much this 10,000 second feet may have added to the crest of the Illinois River flood of 1922, I am wondering if the Sanitary District of Chicago, and the State of Illinois, and the Illinois Society of Engineers has ever seriously considered the feasibility of cutting the Kankakee River into Lake Michigan instead of permitting it to flow as it does now into the Illinois River below the point where the Sanitary District Canal discharges its water into the Illinois

River. The Kankakee River is another factor which has increased the flood levee of the Illinois, by being straightened and otherwise improved. As we understand it also, there is a great deal of agitation about the question as to whether the diversion of water from Lake Michigan into the Illinois River has not permanently lowered the lake levels. Is it, therefore, not worth investigating, to find if a diversion of the water of the Kankakee River into Lake Michigan is not feasible, and by this means restore the lake level and cut down the flowage into the Illinois River approximately as much as the water which the Sanitary District turns in. In other words it seems to us as possibly feasible for this reason that the diversion of water from Lake Michigan into the Illinois River is a diversion of water from one water shed into another and that is all that the diversion of the Kankakee River into Lake Michigan would be when reduced to its simplest terms. It is possible of course that this suggestion is utterly impracticable but many of us in the Illinois River Valley do not feel that we need a Deep Water Way if a Deep Water Way is going to compel us to spend unlimited money to protect ourselves. Another thing; if the Illinois River Valley is eventually put out of business by too much water we do not feel that we would need any Deep Water Way because we would have nothing to haul.

MR. RANDOLPH:—

I think the most interesting aspect of this subject, as presented by Mr. Millard is the appropriation of state money for what appears to be a purely local improvement. On the face of it, that appears to be a questionable policy,—however there are precedents in Illinois for such appropriations. The same thing has been done in the case of Shawneetown, Mounds and Cairo. The question fades into insignificance when it appears these catastrophes cause a great loss of property and often a loss of life and it is consequently not only a loss to the community, but to the state. The public at large throughout the state is usually called on for contributions for immediate relief work, so I feel that there is a jusification for this appropriation.

Mr. Millard referred to the flood of 1844 and said that from all the information at hand it was apparent that the bottoms were so thickly wooded and covered with brush that the channel was probably no larger than it is now, with the improvement of the river bottoms. I think it is probably true that the channel section is no greater than it is now but it is also true that the river had the benefit of the storage capacity of the bottoms at that time. In fact a flood of the same volume as that of 1844, under the present improved condition of the river would undoubtedly reach a stage much higher than the flood stage of 1922. I don't remember the figures exactly, but I believe it was determined the volume of the 1922 flood was less than the volume of the 1904 flood, and at that

rate the flood of 1844 would probably reach a stage thirty per cent higher than that of 1922.

I hold no brief for the Waterways Division of the State Department of Public Works, but in my dealings with them I have found them always ready to coöperate, to meet local demands werever it was possible to meet them, and to co-ordinate the state work with reference to local demands and local sentiment. I think that Mr. Millard and the citizens of Beardstown might reasonably assume that attitude towards the department. Mr. Millard's outline seems to be a reasonable solution of the problem. I think that the state department would not object to such a plan, merely because it would protect some of the land not in the corporate limits of the city. If it is the cheapest plan and will protect the city from overflow, I believe the department would take that attitude about these plans and if the local influences were strong enough to get an appropriation of three hundred fifty thousand dollars, they ought to be strong enough to get the matter fixed the way they want it.

THE WORK OF THE URBANA-CHAMPAIGN SANITARY DISTRICT

C. R. VELZY

It is the purpose of this paper to give a brief description of the work now being carried on by the Urbana-Champaign Sanitary District in building an intercepting sewer and sewage treatment plant for this community.

The subject matter has been divided into three main headings, namely: The problem before the community, some of the considerations forming the basis of design, and a few interesting features of construction.

THE PROBLEM BEFORE THE COMMUNITY

The cities of Urbana and Champaign have had as the only outlet for their sewers the Salt Fork, now called the Saline Ditch, which is a branch of the Vermillion River. The flow in this stream varies from about 10 M. G. D. to about 50 M. G. D. As it takes a natural stream flow of about 3 M. G. D. to handle by dilution the domestic sewage of about 1,000 people, it is evident how inadequate this stream is to take care of the domestic sewage of the two cities with a combined population now of from 35 to 40 thousand people.

The cities have independent sewerage systems. The Urbana outlet is in the northeast part of the city and the Champaign outlet about one-fourth mile still farther down stream, the main sewer of the latter city running through the city of Urbana. Both cities use what is known as separate systems; that is, the storm drains and sanitary sewers are entirely independent of each other.

The sanitary sewers of both cities have also proven inadequate to such an extent that, particularly in Urbana at a number of

points, it has been necessary to provide over-flows into the Bone Yard, which is a small stream flowing through the two cities. During wet weather there is considerable over-flow from the sanitary sewers to this stream and at two points in Urbana there is almost a constant overflow into the Bone Yard even during dry weather. This situation obviously produces an objectionable condition in this stream.

There are several steps necessary to combat conditions of this kind. First—there must be a community organization which is accomplished by the formation of a Sanitary District. Second—there must be the engineering and legal investigations through which are determined the necessary works to be built. Third—the financing of the work is provided for by a popular vote on a bond issue. Fourth—the bond issue having carried, sites and rights of way are acquired and detailed plans and specifications prepared. Fifth—the works are built, and lastly, proper attention must be given to operation, for no sewage treatment works will operate without skilled attendance.

In following the steps indicated the citizens voted on May 24, 1921, to form a Sanitary District and on June 11, 1921, the Board of Trustees of the Urbana-Champaign Sanitary District held their first meeting. The Board appointed the firm of Pearse, Greeley & Hansen to carry on engineering investigations and Judge W. G. Spurgin of Urbana as their attorney. Investigations were immediately started and an engineering report submitted. On November 28, 1922, a special election was held on the proposition of issuing $500,000 in bonds, which carried by majority of about 3 to 1. The firm of Pearse, Greeley & Hansen were authorized to proceed with plans and specifications and the Board acquired a site and the rights of way. Notices to contractors were published on March 12, 1923, and bids were opened on April 16th. On April 17th the contract was awarded to English Brothers, the lowest bidders. We are now in the midst of construction, the work at this time being about one-third completed.

GENERAL FEATURES OF DESIGN

The work preliminary to design includes the study of population and population growth, the quantities of sewage flow including a determination of maximum and minimum flows, a study of the characteristics of the sewage and a study of construction conditions including available head or fall, character of sites available and operating conditions.

The question of population is somewhat involved here because of the presence of the University, which during the school months has a population equal to about one-fourth of the total number of inhabitants.

Investigations of the problem led to a design having the following general features.

The treatment plant, which is considered the more easily ex-

panded part of the works, was designed to care for a population of 50,000 people, which is the predicted total population of the two cities in 1935. The intercepting sewer, which is considered a structure less easily extended, was designed to care for a population of 70,000 people, which is the predicted total population for 1960.

The dry season flow was determined to be an average of 50 G. D. per capita and the wet season flow about 100 G. D. per capita. The plant then was designed for a maximum capacity of 6.75 M. G. D. with a minimum of 1.37 and an average of 2 M. G. D. The sewer at its outlet has a maximum capacity of 9½ M. G. D. and is designed for a minimum flow of 1 M. G. D.

The intercepting sewer begins near the west end of Champaign with a 10 inch tile and from the Illinois Central tracks east follows in general the valley of the Bone Yard to the northeast corner of Urbana where the tile is 30 inches in diameter. It intercepts, on the way, the main sewers of both cities and at its outlet parallels the Champaign main sewer in such a manner that the combined capacities of the existing Champaign sewer and the new interceptor are available. Several crossings of the Bone Yard by existing sanitary sewers are eliminated and a single crossing of the stream is made by the new interceptor by means of an inverted siphon.

The total length of sewer including the branches of the main interceptor is about five miles. About three and one-half miles of this sewer is being built under this contract.

Two processes of treatment were considered in the original report on design of a treatment plant.

1. The activated sludge process and

2. A process of settling in Imhoff tanks and oxidation by sprinkling filters.

For reasons of economy the latter process seemed the better.

The plant as designed, therefore, consists of a screen chamber in which the sewage passes through a coarse bar screen; primary settling tanks of the Imhoff type; a pumping station, which includes laboratory and offices; sprinkling filters; secondary settling tanks of the Dorr type; and a sludge bed for the drying of the solids from the primary settling tank.

Primary settling tanks were designed with a liquid depth of about 30 feet, a displacement period of three hours for the dry season flow, a sludge storage of 2¼ cubic feet per capita, and a gas vent area of 30 per cent of the total tank surface. There are four separate tanks each so baffled as to provide two flowing compartments and three gas vent areas. The bottoms of each tank are built to consist of three hoppers, the sloping sides of which facilitate the collections of sludge at one point for drawing off on the sludge beds.

On account of there being insufficient head to provide gravity flow through the plant, it was necessary to provide pumps. These were placed between the settling tanks and the sprinkling filters.

The total head to be pumped against is about 24 feet. The pumping equipment consists of three vertical centrifugal pumps of 2, 3½ and 5 M. G. D. capacity. The pumps are located in a dry well adjacent to a wet well in such a manner that they can be automatically controlled by float switches.

The sprinkling filters are designed for a population of 45,000. They are built in two units, the stone is 10 feet deep and they cover an area of 1.6 acres. The distribution is through fixed nozzles and the dosing is accomplished by equipment furnished by the Pacific Flush Tank Company. The floor of the filter is built in valleys and ridges with a 12 inch spacing center to center, the valleys being bridged by a clay brick 1½ inches by 4 inches by 14 inches set on edge. This constitutes the under-drain system for the filters.

The sludge beds are designed on the basis of 0.67 of a square foot per capita with provision for easy extention to an area of one square foot per capita. The sludge beds consist of a sand filter placed over gravel and provided with under-drains.

There are two secondary tanks, each 32 feet in diameter. They are equipped with the Dorr clarifiers for continuous removal of sludge, which may be pumped either back to the sludge beds or onto fill in the yard. The secondary tanks are not being built under this contract but probably will be built within the next few years.

It is estimated that the operating cost, including power, will be about $16,800 per year. This provides for a superintendent and two assistants.

INTERESTING FEATURES OF CONSTRUCTION

Upon the opening of bids it was found that for the 30 and 24 inch sizes of sewer, concrete tile was somewhat cheaper than vitrified tile. The District, therefore, chose to use concrete tile on these two sizes and vitrified tile for the smaller sizes. The 24 inch tile was built with a 3 inch wall and the 30 inch with a 3½ inch wall, each being reinforced with a single sheet of wire mesh. The sections of tile in each case were 4 feet long.

Crushing tests were made at the University of Illinois on three sections of 30 inch tile and one section of 24 inch tile. The only standards found by which to judge the results of the tests were those of the American Society for Testing Materials for plain concrete pipe. The specimens tested ran on an average about 30 per cent stronger than the above mentioned standards. Another noticeable feature of the tile shown up by the test was the fact that they stood up fairly well even after the maximum load had been reached. In other words, the load deflection curve was fairly flat rather than sharp, indicating that the tile were not likely to collapse.

A large part of the sewer trenching through the cities has to

be done by hand on account of obstructions encountered. In the more open locations a Keystone excavator has been used.

Varying soil conditions have been encountered. Near the outlet of the sewer where the cut reaches a maximum depth of about 20 feet the banks of the trench were very difficult to hold, although very little ground water was present. In other parts of the trench the soil has been mostly a yellow clay but pockets of sand and sandy clay have been encountered which yield varying quantities of ground water. At some points it was necessary to under-drain the sewer tile and at one locality the flow of ground water was heavy enough to require the constant operation of two diaphram pumps having 3 inch suctions. For the last two weeks the Keystone excavator has been operating to a depth about on a level with the surface of the water in the Bone Yard, which is about one-half block from the trench and there has been very little difficulty from the presence of water. At some points the trench has been entirely free of water.

The largest item of excavation at the site of the plant was the excavation for primary settling tanks. The dimensions were approximately 100 feet by 140 feet by about 33 feet deep. The spoil from this excavation was to be distributed around the site of the plant at from 300 to 600 feet distant from the settling tanks. The Contractor started this excavation with ten Fordson tractors, each dragging a Fresno scraper of about one-half yard capacity. The excavation was carried to a depth of about fifteen feet with this equipment. Some plowing was necessary to loosen the clay so that it could be picked up by a scraper and some hand trimming at the edges of the hole was required but for a distance not more than two feet from the verttical bank.

The rest of the excavation was accomplished partly by a Keystone excavator and the final depth by the use of a steam shovel. Both the latter machines were lowered into the hole simply by traveling down a ramp on one side which was also used for the hauling of the excavation accomplished by these machines. This hauling was done both by teams and Fordson tractors hitched to dump wagons.

This entire excavation was accomplished without sheeting. The soil was mostly yellow clay with pockets of sand and gravel for a depth of about twelve feet and below that level was a very hard, impervious blue clay. This blue clay yielded no ground water although the excavation was carried over ten feet below the level of water in the Saline Ditch which was only about 200 feet distant. The only trouble from water came from the surface water which drained into the excavation. Caving occurred on one side where a stratum of water bearing sandy clay was exposed.

The final trimming of the bottoms for the hoppers of the settling tanks was done by hand and it was found expedient to use dynamite in this work on account of the very hard clay.

Although the extreme limits of the concrete structures for the plant cover a distance of 700 feet, the concrete for all major structures is being mixed at one point in a three bag Koehring mixer. The distribution is accomplished by the use of Insley Industrial track and cars of about one-half yard capacity.

The aggregate for concrete is measured in a patented Johnson measuring hopper. This device consists of a hopper mounted above the mixer having two compartments, one for sand and one for gravel. At the bottom of each compartment is a gated outlet leading into a pair of sheet metal cones, the lower cone with its apex downward and the upper cone with its apex upward. The space between the upper and lower cones is adjustable and by this means the quantity of aggregate which will flow into each set of cones is regulated. This measuring device has proven very satisfactory, giving a very constant yield of concrete per batch.

An interesting problem was presented in the pouring of hopper bottoms for settling tanks. The slope of the sides of the hopper varies from 1-to-1½ to 1-to-2. The sides were too steep to be poured without forms and to pour them with forms and a very dry concrete would make it impossible to obtain a concrete free from honey comb. The problem therefore was to build a top form and to anchor it securely in position and then to hold it against an upward pressure of more or less fluid concrete. The method developed was briefly as follows: A block of concrete was first poured at the bottom or apex of the hopper with a bent bar anchored in it to serve as a tie for the forms. The forms were built over a templet in the yard and lowered into position in sections. Having placed the form, a center post was erected which was wired securely to the anchor in the block of concrete poured at the apex of the hopper. Walers were then placed along the sides of the hopper forms and braces set from the walers to this center post. The braces were set at an angle of about 30° with the horizontal so that any upward pressure resulting from a tendency of any part of the form to rise would be transferred to the center post, which was securely anchored to the bottom. In addition to this, the form was fairly covered with bags of sand which were placed as the concrete was poured. This method enabled the hoppers to be poured with no appreciable movement of forms.

COURT DECISIONS AFFECTING LOCAL IMPROVEMENT ACTS

Attorney Oscar C. Hoose, Bloomington

The year 1923, from the standpoint of the number of decisions of the Illinois Supreme Court, interpretive of the Local Improvement Statute, has not been a very generous one. A total of only nine opinions were filed during the entire twelve months. The possible explanation of this comparative scarcity inheres in the fact that there was a general let-up in improvement activities for

several years following the war. Naturally, only a small number of the proceedings would be taken to the Supreme Tribunal for final decision.

In the recorded decisions there were decided many questions which would be of little interest here. Such questions as legal procedure and practice, rules of court, admissability of evidence, etc., while important to the prosecution of special assessment proceedings are not essential, from an engineering view-point in the proper preparation of data and a legal planning of a local improvement scheme. Therefore, only such matters which have been passed upon which affect the lay-out of an improvement, what should be included and excluded, the things which should be taken into consideration and be avoided, will be brought to your attention.

In the case of Ownby *vs.* The City of Mattoon, 306 Ill. 552 the Court adhered to a previous decision to the effect that tile drains laid cross-wise in the street to the curb line, regardless of whether they may or may not be used as house connections, or whether they are provided for all abutting properties, their main purpose being to provide surface and storm water drains, do not constitute the improvement a double one. The decision in effect is that house connections may be legally made a part of a pavement scheme.

It was contended that the same ordinance was at fatal variance with the estimate because the former provided for a top dressing of sand while the latter provided that the filler was to be used in the cracks for the purpose of binding the brick together and making a uniform surface. The court held the objection was not good because the top dressing was a standard method of construction and the estimate did not need to contain a complete inventory of every article that is to enter into the construction of the improvement.

The ordinance provided that the curb should be five inches wide at the top and six inches wide at the bottom; the estimate provided for curb five inches in width; the Court held the objection invalid under the rule that it is proper in the ordinance to describe the method of construction in detail.

There was an attempt in this case to show that the assessment roll was computed by the Engineer for the City, handed to the Commissioner and by her copied. The Court said that it did not render the roll illegal if the Commissioner received assistance and adopted the suggestions of those who assisted.

The Case of the People *vs.* Ill. Central R. R. Co. (307 Ill. 458) settles a question which has always been of concern to municipalities; holding "that a tax for the payment of public benefits assessed against a city in the making of public improvements must be included in the levy for general corporate purposes unless expressly exempted from the Statutory Limitation and that the Statute authorizing the levy of an additional tax for the creation of a public benefit fund did not so exempt it." In some instances, County Clerks have extended the amount of a public benefit assessment

over and above the general levy of a city for corporate taxes. The holding in the above case compels a city to pay assessments for public benefits out of its general levy.

In the case of David Davis *vs.* the City of Bloomington (309 Ill. 20) the ordinance was held invalid because the ordinance and the plat accompanying it, failed to show the length and depth of the drains or locating the sewer or inlets. The opinion states that "the Court will not take judicial notice of the location of an existing sewer." It would seem therefore that it is necessary, in drafting a valid ordinance that the location of the existing sewer be shown and just how the draininge under contemplation be connected with it.

It would be well for anyone contemplating the planning of an outlet sewer to familiarize himself with the law laid down by our Supreme Court in the case of Harmon *vs.* The Village of Arthur. (309 Ill. 95). The gist of the decision is that "where the construction of a proposed outlet to a storm sewer system depends on the future action of drainage commissioners through whose district the outlet passes beyond the City limits, the city cannot levy a special assessment on property in the City of the proposed improvement." It is necessary under this decision, that the municipality acquire the exclusive use and control of the outlet.

The case of the City of Carterville *vs.* Phillips (309 Ill. 433) makes it incumbent upon a municipality before levying an assessment to pay the cost of a water distribution system to provide positively and unconditionally for a water supply. The City of Carterville had made provisions for a supply by issuing water certificates which were to be subject to the approving opinion of an attorney. In substance the Court held that because there was a possibility that the certificates might not be valid and the supply system consequently never installed that a distribution system, useless without the supply, could not be financed by special assessment proceedings.

The Fifty Third General Assembly of the State of Illinois in 1923 passed many bills which are of interest to those engaged in the construction and planning of local improvements. Only the main features of the principal ones are here given, the details being left for a thorough and comprehensive reading of each.

Senate Bill No. 556 provides that whenever it becomes necessary to change or re-locate the channel of a natural water course within a city for the purpose of laying out, altering or improving a street, the cost of the same may be met by special assessment.

The Statute prior to 1923 provided that special assessment bonds should bear six per cent interest; it is now permissable to issue bonds bearing interest not to exceed six per cent and not less than four per cent.

Of extreme importance to this assemblage is the amendment to Section 94 of the Local Improvement Act by the addition of the following paragraph. "The limitation in the foregoing proviso

(referring to the usual six per cent to be added as the cost of making, levying and collecting the assessment) shall not apply to the costs of engineering and inspection connected with any local improvement, but such costs in cities having a population of less than 100,000, as aforesaid, may be included in the cost of the improvement to be defrayed by special assessment or special tax." A statutory provision of this kind has for a long time been needed, for the reason that the six per cent always allowed has not been sufficient to pay Engineering, legal and inspection fees and there was a consequent drain on the already over-taxed city's finances. It is justified by the fact that Engineering services are a real component part of every improvement.

Quite a few changes were made in the Statue relative to advertisements for bids in cities operating under the Commission form of Government. A careful reading of Section 54 of the Local Improvement act as amended, is urged to those interested.

Additional authority was given cities by the enactment of a new statute for the repair, maintenance, re-surfacing or re-construction of street improvements.

RECOMMENDATIONS

In the very nature of things, it becomes the duty of an Engineer in charge of a local improvement scheme to prepare and formulate the detail descriptive work of estimates, resolutions and ordinances. Having made the surveys and prepared the plans and profiles, he is better qualified, than is the attorney, to properly and efficiently describe and set down the general and specific portions of the undertaking. It is suggested in this part of the work that an orderly, systematic and sequential arrangement be followed. It should be made to stand out in words exactly as it does in lines on the blue print.

The explanation of the various elements of the construction should be respectively grouped together. One phase of the undertaking should be taken up and completely disposed of before another is begun. To illustrate: a pavement ordinance should describe the various widths in one paragraph; intersections should be grouped together; all excepted portions should be shown in one place in the description.

It is advisable after the plan is set forth to describe the improvement in the exact manner as it is to be constructed—the preparation of the sub-grade, laying of curb, the base, the cushion, the wearing surface and the filler.

An orderly, systematic and sequential arrangement of the descriptive work serves many purposes—it avoids confusion in checking, it insures including everything that will make the description complete; it avoids repetition and unnecessary length; it obviates the possibility of variances and makes a product which will more nearly meet the favor of courts of trial and review.

It is next suggested that highly technical terms and unnecessarily verbose paragraphs of description be eliminated as far as possible. The object at hand is the preparation of a document

which will assist in and will stand the test at the hearing in Court. The simplest, if it is sufficient, language that can be used is always the best.

The following words once appeared in a pavement ordinance: "Said concrete footings and support taken in connection with the curb and pavement base form the frustrum of a prism whose base is 8 inches wide by 12 inches long, height ten inches; the top face 4 inches wide by twelve inches long and the vertical face 4 inches by 12 inches."

No question was raised in the trial court on this point but when a transcript of the proceedings was forwarded to a bond attorney for his opinion, he stated that after years of experience he could not figure out what the paragraph meant. When informed that it meant that the triangular chip was knocked off the lower end of the curb and concrete poured in for a support, he very pertinently remarked—"Well why didn't you say it that way?"

It is further suggested that all matters which are purely contract features be eliminated from the ordinance. The following are examples:—During the construction of the improvement the intersecting streets or open street ends shall be barricaded and red lights placed thereat; the amount of the bond to be furnished by contractor and the securities required; the disposition of waste and surplus material; the location and limitations on contractors camps; use of explosive material; these and many others are sometimes set forth in ordinances. They are not only unnecessary but are out of place. They are items to be dealt with in the written contract between the successful bidder and the municipality.

There is an unusualness about your profession that is characteristic of few others; yours is always a work of a constructive nature. There should be a great satisfaction to you in the knowledge that you are following a life vocation which is creative and constructive in its nature. Each endeavor of yours is calculated to improve and better the condition of affairs in the community you serve.

And, too, there are many responsibilities. The problems of millions of people, involving not only their property, but their health and safety as well are directed to you for solution. The destinies of municipalities and communities rest in your hands.

This confidence of Fate has been well reposed. The high-mindedness, the earnest studiousness and eminent fairness of those who have accepted their duties and responsibilities justify the wisdom of the choice and have made civil engineering one of the learned and honored professions of the world.

RECENT CHANGES IN CHICAGO PAVING ORDINANCES

J. B. HITTELL

In the proposed paving of the Maryland Avenue System of Streets, the following Engineer's estimate was submitted to the

interested property holders and considered at the public hearing.

Concrete combined curb and gutter on cinders, gravel or sand, 27,450 lineal feet at $1.15	$ 31,567.50
Filling, 20,000 cubic yards at $2.50	50,000.00
Paving with standard asphalt wearing surface and binder course on six inches of Portland cement concrete swept with natural hydraulic cement, 43,800 square yards at $3.50	153,300.00
Constructing 47 new brick catchbasins complete at $105.00	4,935.00
Adjusting abutting sidewalks	1,500.00
Adjusting abutting pavements	500.00
Adjusting sewer manholes and catchbasins, and constructing and connecting catchbasin inlets	23,912.00
Deficiency in interest on the assessment, cost of making, levying and collecting said assessment, and lawful expenses attending the making of said improvement	13,285.50
Total	$ 279,000.00

At the hearing the resolution was amended providing for "new concrete" in lieu of the new brick catchbasins, and the ordinance as submitted to the City Council contained among others, these clauses:

"The pavements abutting on each of said above specified streets, where necessary, shall be so adjusted as to conform to the surface of the finished pavement herein described.

"The sidewalks abutting on each of said above specified streets, where necessary, shall be so adjusted as to conform to the curb elevations herein described.

"Twelve (12) new concrete catchbasins shall be constructed and trapped and connected with the sewer in Maryland Avenue, and located in the roadway of said Maryland Avenue at necessary points, adjacent to the curb lines of said Maryland Avenue.

"Each of said catchbasins shall be connected with the sewer with tile pipe of eight (8) inches internal diameter and shall be trapped with an eight (8) inch tile pipe half-trap. The inside bottom of each of the said tile pipe half-traps shall be set three (3) feet six (6) inches above the said floor of each of said catchbasins.

"Each of said catchbasins shall be provided with a suitable cast-iron cover, each of which covers, inclusive of lid, shall weigh five hundred forty (540) pounds. Each of said cast-iron covers shall be set so that the top of the same shall coincide with the surface of the finished pavement herein described.

"The existing sewer manholes and catchbasins located in said roadway shall be so adjusted as to make the top of the cover of each of the said sewer manholes or catchbasins conform to the upper surface of the said pavement; and the existing catchbasins, necessary to this improvement, located outside of said roadway shall be so adjusted as to make the top of the cover of each of the said catchbasins conform to the elevations herein prescribed. The existing catchbasins located on the line of the curb shall be so adjusted as to make the top of the cover of each of the said catchbasins conform to the upper surface of the said pavement, or to the said elevations according to whether the major part of said catchbasin lies within or without the

said roadway. Catchbasin inlets shall be constructed at necessary points in said gutters. The catchbasins which are not located in the gutters shall be connected with said inlets by means of tile pipe of eight (8) inches inside diameter."

The estimated cost of the improvement, being in excess of $100,000, was referred by the Council to the Committee on Streets and Alleys which held several hearings at which the arguments for masonry construction and concrete construction in catchbasins were presented by the different interests. The Committee reported the ordinance favorably, and it was adopted and passed by the Council.

The case was called for trial Octotber 3, 1923, before Judge Hoover. The confirmation was opposed by several attorneys representing 15 per cent of the property owners. The ordinance was attacked on the following grounds:

1. The ordinance provided for adjusting existing sewer manholes and catchbasins, and constructing catchbasin inlets, the cost of which was estimated in a lump sum. The attorneys opposing confirmation attacked this provision, first, because the costs were not itemized, and second, because the type of inlet was not specified where the existing catchbasins were not in the roadway adjacent to the curb, and could not be used directly as inlets. Therefore, a type of inlet known as a grate or gutter box was to be used and connected to the catchbasin. Opposing attorneys then called the attention of the Court to the fact that the grate type of inlet was not directly provided for in the ordinance and material for its construction was not specified, and provision for its connection to existing sewers, if there were any, was not shown.

2. These attorneys also contended that the elevation of the 8 inch tile pipe connection from new catchbasins should be shown at a point of connection with sewer in streets and the location of new catchbasins shown; and further that the ordinance should show a connection downward to the sewer; the elevation of catchbasins being known, the elevation of the sewer should also be known. The attorney for the city contended that exact locations could not be shown because a period of one year to two years might elapse between the time the estimate was made by the engineer and the time the street would be paved. Also, some obstruction, such as a public utility conduit or water pipe might interfere with the location of a catchbasin as definitely fixed in the ordinance.

I will cite some excerpts from Judge Hoover's decision in which he dismissed the petition.

"There were a number of objections, of course, filed in this proceeding, but the objections argued and relied upon were those aimed at the valadity of the ordinance itself for the purpose of defeating, if possible, the entire improvement as provided for in the ordinance.

"Taking up the objections, in a general way, in the order in which they were argued, there was, first, the objection to the proceedings of the Board of Local Improvements at the public hearing. The evidence shows that the original resolution of the Board of Local Improvements providing for this improvement, together with the Engineer's estimate,

was, so far as specifications were concerned, a duplicate of the provisions of the ordinance, except that at the public hearing a motion was made, which, in substance, was to change the material used in the construction of the new catchbasins, or in the construction of catchbasins, from brick to concrete. There was no provision made in the motion as to what the specifications should be as to size, shape or dimensions of the new catchbasins, and it was urged that inasmuch as the motion was merely to change the material to be used in the construction that no dimensions of the catchbasins as proposed were given, and that the property owners at the public hearing had no means of knowing what was proposed to be done as to size and location, and so forth, of the proposed new catchbasins.

"I think it may be safely assumed in view of the fact that the original resolution provided specifically as to what the size and shape and dimensions of the catchbasins which were to have been made of brick should be, and that the resolution or motion made at the public hearing made no reference to any change of size or dimensions except a change of material to be used in the construction, that the property owner had a right to go away from the public hearing assuming that the only change made at the public hearing was that instead of being constructed of brick they were to be constructed of concrete. That was the only amendment to the original resolution that was made at the public hearing.

"Now, it is contended, sections 7 and 8 provided that there must be a new resolution or an amendment which is before the property owners at the public hearing, but I think in view of all the authorities on that question that the motion which was carried by the Board is, in itself, sufficient, but the difficulty with it is that after amendment was made in pursuance of the resolution, the engineer who made the amendment in compliance with the resolution changed somewhat the dimensions of the catchbasins as provided for in the original resolution. The original resolution provided for a wall in catchbasins eight inches thick. The amendment made to that resolution provided for a wall in catchbasins five inches thick and a depth of seven feet instead of seven feet and two inches. It is contended that these changes constituted a variance which was fatal to the ordinance. If this were the only question involved, this Court would be inclined to hold that variance was not a material variance, at least not of sufficient importance on that one proposition to invalidate this ordinance. But, that is not the only objection urged. I might suggest that it seems to me that to strictly comply with sections 7 and 8, that there should be, if there are any changes in the original resolution—I believe the spirit of the statute is that the property owner at the public hearing must know and has a right to know at that public hearing just what those changes are going to be. If it is a change in material, if it is a change in dimensions, if it is a change in location, or any other changes, the motion or resolution should specify what they should be.

"The ordinance before us in the Maryland Avenue case has a general provision that the connection shall be made with the sewer of each of the streets respectively, and you might infer from the reading of the ordinance, although there is no allegation particularly to that effect, but such an inference could be drawn from the general language, that there are sewers in certain of these streets, but the ordinance and the resolution in this case . . . . do not give the location of the sewers. It is impossible to determine from any of the proceedings in this case where the sewers are located, except from a plat which was introduced in evidence during the hearing of the case. It is contended by the objectors here that it is incumbent upon the city in preparing this ordinance, upon the engineering department, to state what the length of these drains shall be and what the grade shall be at which they are to be laid, and the location of the catchbasins. In this case there is noth-

ing said relative to grades, nothing to indicate the location of the sewer, whether it is in one part of the street or another, and nothing to indicate the location of the manholes, except left to the discretion of the engineer. . . . . The ordinance in the Davis case does provide what the fall of the pipe shall be from the catchbasin to the sewer—one-fourth of an inch for each foot. This does not make any provision as to whether the pipe shall run up-hill or down.

"It is contended on the part of the City that some of these objections are somewhat hyper-critical, and that certain things must be left to the discretion of the engineer, and to what the Supreme Court has been pleased to term the "exigencies of construction," and that in the actual improvement they run across conditions when excavations are made which cannot be foreseen, and that, therefore, to describe the exact location of these catchbasins, would be if not an impossibility an impracticability. It is urged, however, on the part of the objectors that that theory is disproved by the facts in this case, because during the hearing of this case a plat was prepared which set forth the grades and all of the matters for which substantially an objection had been raised. In other words, the question of the location of the sewers, the question of grades and all these questions are things that are peculiarly within the knowledge of the petitioner. The fact that they prepared that during the hearing ,it is insisted should be deemed by the Court as some evidence that these grades could be established and all these matters ascertained prior to the inception of the proceeding with just as much accuracy and just as much detail as they can during the hearing.

"Trying to take as broad a view as the Court can of the situation, in view of the tendency of the decisions of the Supreme Court within late years toward requiring full specifications as to the kind, character and location and so forth of the improvements, it does seem to me that this knowledge, being within the knowledge of the City (they have their map department and their records as to where all these improvements are) can substantially comply with the ruling of the Supreme Court on these matters. Let us assume that you did in your ordinance provide with certainty that certain things in an improvement, as for instance, a catchbasin or other component part of the improvement, shall be located at a certain place, and when you begin excavating there you find by reason of underground work or other obstacles you cannot locate it at that particular place, it must be changed somewhat, and in that respect varies from the provisions in the ordinance as to the location or the shape or the style provided in the ordinance, it seems to me that the Local Improvement Act provides for that, because, if your ordinance provides that a thing shall be at a certain specific spot, and you find it is impossible as a matter of construction to place it there as provided in the ordinance, under section 84, when you apply to the Court for a certitficate of completion, the law providing that upon a showing that the work has been done in substantial compliance with the statute, allows the room for this discretion in the method of construction which it is contended on the part of the city the engineer of the Board of Local Improvements should have. Because, if you show in your application for final certificate, and somebody objects that a manhole or catchbasin is not placed where the ordinance provides, and you show in making that improvement you ran upon water pipes or some other obstacles that prevented your putting it there, can you imagine any Court in the world that would refuse to give a certificate of final completion as a substantial compliance when it is shown to the Court that as an engineering proposition it is impracticable to place it the same as the ordinance provided? So, it does not seem to me, after going into these authorities thoroughly, that it is the intent of the Supreme Court or the Legislature that these matters of discretion should be left with the Board

of Local Improvements or with the Engineering Department in the ordinance, but that it is a matter of discretion that might arise where by force of circumstances or necessity there was necessarily some discretion used, where they made some slight variance from the provisions of the ordinance.

"Now, speaking about this question of discretion and the impossibility of doing certain things on the part of the City, the Supreme Court has already passed upon that subject in only a general way, yet, it indicates what the law of this State is, and the language of the Supreme Court is this

> 'For this reason it is said that the improvement cannot be described but its character must depend upon the exigencies of construction. The obvious answer to this is that if the City is not able to specify the nature, character, locality and description of the improvement, it is not authorized to make it by special assessment at the expense of the property owners. The legislature has fixed the conditions upon which the special assessment may be levied.'

"I might go ahead and say a good many things about these inlets, about the provisions for connecting the drains to the catchbasins, about the question of whether or not these drains from the catchbasins to the sewers are provided for and how they are provided for, but this ordinance does not say—it says the drains shall lead from the catchbasins to the sewer, but does not say whether you shall take a maul and knock a hole in the pipe or connect them with Y's. All those things, in my judgment, should be provided for. I think there is no need of saying anything upon the question of the reasonableness of this improvement. I think it is reasonable and I think it is an improvement that is badly needed, but that will not cure the ordinance."

In consequence of this drastic opinion, a conference was held between the attorneys and engineers of the Board, at which the former contended it would be useless to go into Court unless the estimates and ordinances were considerably more in detail than they had been in the past, especially with reference to the items of sewer adjustment work, sidewalk construction and adjusting of abutting pavements.

Realizing that it is almost an impossibility to visualize in advance just the necessary amount of work to be done at street and sidewalk intersections, it was determined that all reference to these operations should be omitted; and any cure, if necessary, should come from a collateral ordinance requiring the Commissioner of Public Works to adjust the walks and pavements at intersections, and pay the same from the general maintenance fund of the city.

To meet with the other objections, a copy of an estimate and extracts from one of the recent ordinances will show how this is attempted to be done.

ENGINEER'S ESTIMATE OF COST OF IMPROVEMENT

Asphalt pavement with foundation, 4520 square yards @ $4.00	$18,080.00
Concrete curb and gutter with foundation and backfilling 2730 lineal feet @ $1.25	3,412.50
Cutting, 3085 cubic yards @ $2.50	7,712.50
New concrete catchbasins complete, 4 @ $105.00	420.00
Catchbasin inlets complete, 14 @ $40.00	560.00
8-inch tile pipe catchbasin connections, 220 lineal feet @ $3.00	660.00
Sewer manholes adjusted, 9 @ $9.00	81.00
Sewer catchbasins adjusted, 14 @ $40.00	560.00
New iron covers, 14 @ $30.00	420.00
Deficiency in interest on assessment, cost of making, levying and collecting said assessment, and the lawful expense attending the making of said improvement	1,594.00
Total	$33,500.00

"Four (4) new concrete catchbasins shall be built, trapped and connected with the sewer in the center of said North Neva Avenue and located in the roadway of said North Neva Avenue adjacent to the curb lines at points as follows: two (2) sixty (60) feet south of West Grand Avenue and two (2) sixty (60) feet north of Palmer Street.

"Each of the catchbasins herein provided shall be cylindrical in shape and shall have an internal diameter of four (4) feet, excepting the upper portion two (2) feet and six (6) inches in height which shall be conical in shape, being reduced to two (2) feet internal diameter at the top. The wall of each of said catchbasins shall be five (5) inches in thickness and shall rest upon a floor of pine plank two (2) inches in thickness, which shall be covered with a layer of concrete three (3) inches in thickness. Each of said catchbasins shall be seven (7) feet and six (6) inches in depth, measuring from the top of the concrete wall to the top of the concrete floor.

"Each of said catchbasins shall be trapped with an eight (8) inch tile pipe half trap. The inside bottom of said half traps shall be set three (3) feet above the said floor of each of said catchbasins. Each of said half traps shall be connected in a direct line, which shall slope downward, to the sewer herein specified by means of tile pipe of eight (8) inches internal diameter.

"The elevation of the center of the said eight (8) inch pipes where they connect with the sewer at said point sixty (60) feet south of West Grand Avenue shall be fifty-nine (59) feet above said Chicago City datum, and at said point sixty (60) feet north of Palmer Street shall be sixty-four and twenty one-hundredths (64.20) feet above said Chicago City datum."

* * * *

"The existing catchbasins located in the sidewalk space adjacent to the curb lines of said North Neva Avenue shall be so adjusted as to make the top of the covers herein provided for said catchbasins conform to the top of the adjacent curb. Each of said catchbasins shall be provided with a suitable cast-iron cover, each of which covers, inclusive of lid, shall weigh three hundred fifteen (315) pounds.

"A catchbasin inlet shall be constructed in the gutter adjacent to each of the existing catchbasins. Each of said inlets shall consist of a suitable cast-iron grating twenty-one and one-half (21½) inches by fourteen and one-half (14½) inches, weighing ninety (90) pounds, supported in a suitable cast-iron frame weighing one hundred ninety (190) pounds, set upon a concrete foundation composed of one (1)

part of Portland cement, three (3) parts of clean torpedo sand and five (5) parts of crushed stone or gravel.

"The concrete foundation for said inlets shall be thirty-six (36) inches in depth, twenty-five (25) inches in width and thirty-eight (38) inches in length, with a suitable opening through the foundation connecting the grating with the eight (8) inch tile pipe hereinafter provided leading to the adjacent catchbasin.

"Each of said inlets shall be connected with the adjacent catchbasin by means of tile pipe of eight (8) inches internal diameter. The center of the eight (8) inch tile pipe at its connection with the opening in the foundation shall be thirty-three (33) inches below the top of said grating, and at the connection with the catchbasin shall be forty-five (45) inches below the top of the cover of the said catchbasin.

"The top of said cast-iron gratings shall conform to the upper surface of the gutter immediately adjacent."

It would seem, at least to one whose education is not along legal lines, that the courts have laid stress on the need of furnishing detailed information to the property holders—information which a great majority of them is incapable of appreciating, or if understood, the value of it is very questionable. Yet it must be taken into consideration that a law that places the power practically in the hands of six men in the City of Chicago, to levy additional taxation of ten to twelve million dollars a year upon the property holders, should be such as to safeguard every right of the latter.

I am of the opinion that the present laws must soon be rewritten in order to obviate the effect of inconsequential objections.

THE RELATION OF THE SUBGRADE TO THE WEARING SURFACE OF ROADS AND PAVEMENTS

W. P. BLAIR

National Paving Brick Manufacturers Association

In view of the recent but well established effect of water or moisture in rendering subgrades uncertain, variable, and lacking as a support to the artificial wearing surfaces of our roads and pavements, it becomes the task of the engineer to exercise his utmost ingenuity and ability to eliminate the water or moisture from the soil that furnishes the ultimate support to any structure.

The bearing power and supporting strength of the subgrade will be in proportion to its dryness and freedom from moisture and, unless the water in the subgrade is reduced to a minimum, the intermittent expansion and contraction due to the presence of water or moisture will impair the wearing surface to a greater or less extent, according to the amount of water present.

The character of the soil composing the subgrade should determine the treatment which will most effectively eliminate the moisture content. The kind of treatment must therefore vary with the character of the soil if economy is to be conserved and efficiency attained. Some soils are closer grained and very plastic and difficult to drain when once saturated with water. Other soils con-

taining a greater or less proportion of sand and gravel, are readily drained and are more easily maintained in a dry condition. The range of contraction and expansion is much greater with the close grained soils than those containing sand and gravel, hence the greater damage exerted by subgrades composed of such soils, lacking in coarse materials, so that it is all the more important to maintain in a dry state, the soils that are the most difficult of drainage.

On portions of roads stretches are often found wherein the natural conditions are such that the gravel and sand are intermixed with the soils which, together with the surrounding topography, are such that but little artificial treatment is needed to stabilize the subgrade. The natural condition found is largely sufficient.

It follows therefore, that road design over any great distance must vary in accordance with conditions found enroute, if we are to construct our roads with no greater expense than is necessary to build the road commensurate with the traffic imposed.

It has been found that a layer of coarse material, gravel, broken stone or slag, placed approximately two and one-half feet below the surface of the pavement, very greatly obstructs the upward flow of water by capillary force, into so much of the subgrade and artificial base of whatever character, and thereby insures a uniform stabilization of the entire structure overlying the layer of such coarse material. This measure of treatment may be thought to involve expense beyond the benefit secured; but the powerful grading and excavating machinery now available for trenching the entire width of the structure and in turn throwing back the earth, covering the layer of broken stone, is really not expensive when the proper implements are used in handling the soil.

After the installation of the layer of coarse material to the width of the wearing surface of the road, it is quite possible to extend the layer of coarse material through the berm to the longitudinal disposal drains at the roadside.

The money saved in this character of road construction, is clearly compensated for in the avoidance of subsequent expense that follows in maintenance of roads wherein such provisions are ignored. The item of expense in maintenance and repair, which to a very large extent can be avoided, is the cost of filling and leveling up to the surface which sinks away because there is not sufficient support to hold the surface to its original alignment. The upper thrust of the expansion of the subgrade often destroys and breaks up the wearing surface, and works incessantly in the destruction of the artificial base and wearing surface.

Then too, the acceleration of the expansive force which follows the condition of a subgrade saturated with moisture, subjected to the influence of low temperature, finishes the destruction of the road, regardless of whether it is subject to the use of traffic or not.

The rut into which road building has fallen, not only entails great expense in upkeep, but it affects all sorts of activities with

grim disaster outside the commercial loss. Schools are closed, church doors are locked and gates are closed against social and neighborly uplift which can not be measured in dollars and cents, all due to the careless and thoughtless way of road improvement.

But the still greater calamity that we are facing by ignoring scientific methods which beget durableness of our roads, is the fact that if ignorant road design is adhered to as evidenced by the experience of costly repair of most roads as now built, we shall be utterly unable to finance the repair of the roads when the mileage of so called road improvement reaches figures somewhere near the present popular demand. Then repair will become impossible and hoped for roads will become a disappointment instead of a realization.

OILED EARTH ROADS IN ILLINOIS

JAMES H. REED

County Superintendent of Highways, Cambridge, Ill.

Oiled roads are comparatively new in Illinois and may be considered as still in the experimental or trial stage. Some 12 years ago road oil was in use in a number of places on village streets and country roads on a small scale. Great improvements resulted and the demand for oiled roads has increased until in 1923 not less than 40,000,000 gallons of oil were used on some 10,000 miles of roads and streets.

The writer does not regard the oiled road as a substitute for the hard road but believes our main roads should be paved as rapidly as sound economics permit, and hopes to see the proposed $100,000,000 State bond issue for hard roads voted as a means to that end. However, road oiling has attained such proportions and the improvements made thereby have been so great that he believes the process merits careful consideration and investigation as a means of improving secondary roads, and he proposes to indicate the directions he thinks such investigations might well take and to outline what is being done in Illinois along these and similar lines by road officials and others interested.

The methods at present in use for constructing and maintaining oiled roads should be understood, the results obtained carefully noted, and costs accurately ascertained. The fundamental nature of the oil and the nature of the compounds, mixtures or emulsions formed when oil is applied on the road should be studied, for it would seem that such studies should lead to a better understanding of the properties, or qualities, to be striven for in the manufacture of road oil and of the best methods of using the product. The effects of different soils and slight climatic differences are to be taken into account.

The usual methods of preparing the road and applying the oil are of common observation. The road is graded as early in the

spring as the condition of the ground will permit. It is left open to traffic and is frequently dragged or gone over with some form of maintainer until the oil is applied, the object beeing to have the road settled and as evenly packed and smooth as possible when the oil is put on. The cross section of an oiled road is important. A crown of 12 inches in a width of 24 feet has been found satisfactory on a road with considerable traffic.

In Illinois road oil is usually heated and applied with pressure oilers mounted on motor trucks, though light oils are sometimes successfully applied without heating. The most common form of distributing truck, or spreader, is that in which a rotary pump, driven by the truck motor, forces the oil onto the road through spray nozzles. In this way the oil is applied very uniformly. On country roads different quantities of oil are used, 2500 to 4000 gallons per mile, and one-half to three-quarters gallon per square yard being common figures, with a tendency toward the use of more oil. The cost varies with the price of oil and the distance hauled, but in 1923 was often 6½ to 7 cents per gallon including oil, freight and spreading. Maintenance is carried on, or attempted, with road drags, blade maintainers and similar apparatus.

The greater part of the road oil used in Illinois is applied on the earth roads of the central part of the State, little being used in those northern counties where gravel or rock is available for road building, and little going south of the black soil belt. Within Central Illinois great improvement in roads has resulted from the use of oil although the degree of success attained has not always been everywhere the same.

The oiled roads are at nearly all times better than the unoiled. Except where the soil is light and except during long periods of hot dry weather, the dust is kept down. Summer rains have little detrimental effect on an oiled road, and in the fall, when rains are frequent and evaporation is slow the difference is often such that reports issued by automobile clubs on road conditions frequently contain such notes as "Unoiled roads very muddy, oiled roads good. 90 per cent main roads oiled." "State Aid oiled earth roads in good condition despite rains of last few days." "These three miles are oiled and in good shape at all times."

In the spring oiled road sometimes fail and oiling will not cure "seep holes" which occasionally appear at that time on account of water in the subgrade. On the other hand, some counties report that oiled roads have carried a very considerable traffic uninterruptedly and satisfactorily throughout the year.

As pointing toward the limitations of oiling, it seems that oil does not increase the bearing power of the road above that of the compacted unoiled soil, nor does it form a mat, or oiled crust, or layer of earth mixed with oil, of sufficient strength, as a slab, to distribute wheel loads over any considerable area. At present its possibilities seem to be those which would follow the formation of a surface which will not become dusty and which will shed water.

As to what is being done in a study of the process, outside the actual oiling of roads undertaken by many townships and counties, it may be said that the University of Illinois, the Illinois Division of Highways, certain of the counties and many of the large oil producers and refiners are devoting a great deal of time and study to the subject, both in the laboratory and in the field.

Three experimental roads have been oiled, one at Urbana, by the University, under the charge of Professor W. M. Wilson, one near Rosemond, conducted by the State Division of Highways and Christian County jointly and one near Cambridge, conducted by the State and Henry County. Mr. F. L. Sperry, assistant Engineer of Materials of the Division of Highways has been in immediate charge of the two last named roads for the State. A number of the large oil companies have cooperated earnestly in this work, donating oil in some instances and assisting in every way possible through their engineers and chemists.

A brief description of the experimental road in Henry County will indicate the scope of the work undertaken. The road chosen for the experiment is typical of the most heavily traveled country roads of that part of the State and throughout its length the soil is quite uniform. It is divided into 15 sections each 1000 feet long and each section is oiled with a different kind or quantity of oil. On some sections the total quantity was all applied the same day, and on others the same total quantity was used but it was applied at two or three different times during the season.

Road oils available here are usually residuums resulting from the distillation of crude petroleum. In some instances a heavy residuum is "cut back" with a lighter oil and sometimes different residuums are blended. By different kinds of oil is meant distinct types, distinguished by the source, or field, supplying the crude from which the road oil is made or by the process of refining, and all the various types supplied commercially in Illinois have been used in these experiments.

The experiments in Henry County have been in progress during the past six months only and it is felt that definite conclusions as to the best kinds of oil for the purpose and the best methods of construction should not be drawn from these experiments before the road has, at least, gone through the drying conditions of spring, especially as the comparative condition of the several sections changes rapidly and continually. However many interesting, and sometimes unsuspected, facts have been observed which appear to be factors in the success of an oiled road, and certain things seem fairly well established. For instance it seems likely that three-fourths of a gallon per square yard is the minimum that can be depended on through the year and much better results have been obtained when the entire quantity was not applied all in the spring, but part was reserved until late in the summer.

It is planned to continue the experimental roads in 1924 with the work of the University, the Division of Highways and the

counties concerned carefully coordinated, and it is the hope of those connected with the work that information will be obtained which, added to the experience accumulating in oiling, will lead to a determination of the proper field for this method of road improvement and to the economical construction within that field, of good and dependable oiled roads.

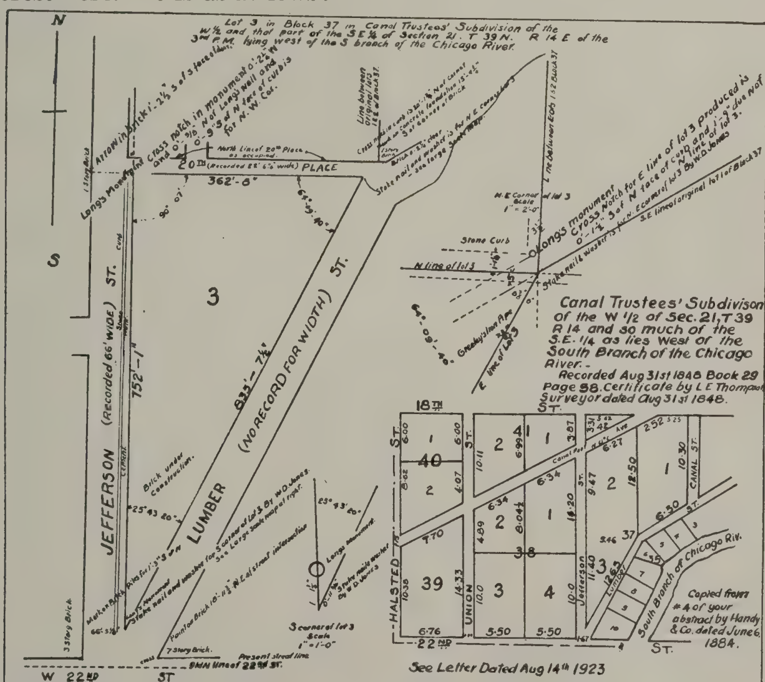
A DIFFICULT CASE IN CHICAGO LOT LINES

W. D. JONES

Some Surveyors think they should never tell their clients any of their difficulties in reach a conclusion as to corners in a survey, or give them any kind of a report, except their final conclusions in the form of a plat of survey.

They think it would be a weakness on their part to suggest a possibility that some other surveyor might disagree with them on the location of a corner.

It seems to me that whenever there is a chance for disagreement the client is entitled to know that fact, and that a report is in order. Such a report I made last August to the Western Shade Cloth Co. of Chicago. It was thought the same might be of interest here. It is as follows:



GENTLEMEN:

Referring to my plat of survey No. 7605 of Lot 3 in Block 37, of Canal Trustees Subdivision etc., as was known to you when you ordered this survey made by me, good surveyors differ in their opinions as to where the lines and corners of this lot are. I should not like to say that these differences are caused because either of the surveyors in question have made a mistake. By that I mean that I think said surveyors have not in any particular survey placed the lines and corners of said Lot 3 different than they intended to place them at that time. The subdivision by the Canal Trustee's which created said Lot 3 was recorded August 31, 1848. We must, therefore, assume that the original stakes, or other monument creating the lines and corners of said Lot 3 were set about that time. To the best of my knowledge and belief (and I feel very sure I know) no one now living claims to have found the said original monuments which created the corners of said Lot 3 or to have any positive knowledge as to where said monuments were placed in 1848, yet that is the knowledge we are all looking for.

Not being able to tell positively where said monuments were placed in 1848 because they have long ago disappeared the question is, what is the best evidence as to where they were placed, what the best theory of a survey to replace them where they were originally.

You will be able to see that upon these points there is room for difference of opinion. There is only one who has final say upon whose opinion is correct and he is the Judge of the Supreme Court. Said Court may know less about said corners and lines than any of the surveyors know, but he has the advantage of hearing what all the surveyors have to say and he is the one to whom the law gives the power of final decision.

I shall herein set out certain points in my theory of the survey and shall be glad to explain further to you or your lawyer, any points that may not be clear to you.

The main point of difference in the surveys is as to the location of the N. E. Corner of said Lot 3, I differ with both of the other surveyors on this corner. (See plat.) No. 4 of your abstract shows a copy of the original plat of Block 37 Canal Trustees Sub. etc. See copy of same on our Plat No. 7605. I hold that according to this plat the N. E. Corner of Lot 3 is a common corner with the S. E. Corner of said Lot 2 and with the S. W. Corner of Lot 1, all in said Block 37. I hold that any theory of survey which locates the N. E. Corner of said Lot 3 not at a common corner with said corners of said Lots 1 and 2 of said Block 37 must of necessity be in error. Now, I agree exactly at this point with Mr. Greeley as to the location of the North and South line between said Lot 1 and 2 of said Block 37 and if there is any difference with Mr. Lang as to the said location of said North and South line between said Lots 1 and 2, it is very slight and is mainly caused by our difference as to the East line of Jefferson Street at the N. W. Corner of said Lot 3. We all

agree in theory and very closely in practice (if not absolutely) as to the location of this North and South line between said Lots 1 and 2 at this point.

As stated above I hold that the location of the said North and South line between said Lots 1 and 2 is one of the principal controlling factors in the location of the N. E. Corner of said Lot 3, Block 37; that is, that the N. E. Corner of Lot 3 is on said line. Said corner must also be the angle corner in the Northwesterly line of Lumber Street.

Therefore, the problem was to find a reasonable angle corner for the Northwesterly line of Lumber Street, on said North and South line between said Lots 1 and 2, which should also be the East end of a reasonable North line of said Lot 3, Block 37. I tried several theories for doing this which I had to discard as not reasonable, in view of what I found upon the ground. The theory that I used was this: I calculated the angle at the N. W. Corner of Lot 3, South to East, by using the recorded length of the three sides of Lot 3, and found said angle to be 90° 7′. After locating the N. W. Corner of said Lot 3, I turned this angle of 90° 7′ with the west line of Lot 3 (or the East line of Jefferson Street) for the North line of Lot 3 and found that the North line of Lot 3, so taken, intersected the said North and South line between said Lots 1 and 2, Block 37 at the Southeasterly line of Lot 1, as occupied. This gives us a common corner for the said N. E. Corner of said Lot 3 with the said corners of the other two lots of Block 37 at the South end of the North and South line between said Lot 1 and 2, Block 37 about which line between lots 1 and 2 there is no difference between surveyors as to its location.

Now, as to the south corner of Lot 3, Block 37 there is plenty of room for argument within the limits of difference, as shown on our plat No. 7605. It is all a matter of interpretation of the said original plat of subdivision by the Canal Trustees recorded in 1848, and no one can know what the decision of the court will be until it is made. There is no recorded width for Lumber Street. (See original plat shown as No. 4 of your abstract).

No. 4 of your abstract not only does not show any width for Lumber Street, but marks it with a W, near the South end of Lot 3, which means that the width of Lumber Street is wanting.

Now, the width of Jefferson Street is recorded as 1.00 chains = 66 feet. The distance between the N. W. Corner of Jefferson Street and 22nd Street to the N. E. Corner of Lumber Street and 22nd Street is recorded as 1.67 chains = 110.22 feet, so that it is possible to locate accurately the east line of Lumber Street at the original North line of 22nd Street and upon this location there is no difference in the surveys.

Now, there is no recorded distance between the North line of 22nd Street and the south corner of said Lot 3, but it is possible to calculate from the original records at Union Street and on the west line of Jefferson Street what the original measurement was on the

East line of Jefferson Street between the North line of 22nd Street and the south line of 18th Street and by taking from this measurement the sums of the records given from the south line of 18th Street to the south corner of Lot 3 we have what was left to the North line of 22nd Street from the said south corner of said Lot 3. I understand from Mr. Greeley that by using this method of finding the distance from the North line of 22nd Street to the South corner of Lot 3, and using the other records on the original plat, without using any present survey measurements, he calculated the width of Lumber Street to be within a few inches of 66 feet and that his figures were shown to the Court in said Case No. 332466, and argument was made that therefore said Lumber Street was intended to be 66 feet wide. Mr. Greeley and Mr. Lang in their surveys have both used Lumber Street as 66 feet wide.

A survey by Mr. Greeley showing Lumber Street as 66 feet wide has been recorded (See No. 5 page 33 of your abstract). This is not, however, a plat of subdivision and does not, therefore, make or dedicate Lumber Street as 66 feet wide, but it is a notice to other surveyors and to the public that in Mr. Greeley's opinion Lumber Street is 66 feet wide.

I have located the south corner of Lot 3 at a distance of 59.16 feet north of the original North line of 22nd Street and on the East line of Jefferson Street. This distance of 59.16 feet I obtained from the original records as explained above. By so doing I find the said corner to come 1.10 feet South of Mr. Lang's monument for the same corner. By so doing I find the Westerly line of Lumber Street at this point to be 0.47 feet Easterly from Mr. Lang's monument. My point for the south corner of Lot 3 is 65.50 feet westerly from the Brick Building on the Easterly side of Lumber Street.

Now, I also calculated the width of Lumber Street at the south corner of Lot 3 by using said distance of 59.16 feet North of the North line of 22nd Street to said South corner of Lot 3, and other records on the original plat of subdivision and found, by using the angle given for Lumber Street (i. e. N. 25° 05′ E) a width of 65.13 feet, and by using the record length of the 3 sides of Lots 3 a width of 65.42 feet for said Lumber Street.

Now, I agree with Mr. Greeley that this shows the probable intention of the original surveyor to make Lumber Street 1 chain = 66 feet wide, but I hold that said original surveyor did not do so at the South Corner of Lot 3, Block 37.

In order to make Lumber Street fully 66 feet wide at the south corner of Lot 3 it is necessary to move the said south corner of Lot 3 north of where we have determined by the records, as explained above, that it should be.

In order to make Lumber Street fully 66 feet wide at the south corner of Lot 3 we must change the distance, obtained from the records, by which we calculated the width of Lumber Street. I hold that this should not be done.

Assuming that the original surveyor staked the blocks and lots in this subdivision, the records show that he set a stake 59.16 feet North of the North line of 22nd Street, as explained above, for the south corner of Lot 3 Block 37. He must have also set stakes for the lots on the Easterly line of Lumber Street in Block 35. He probably then measured the width of Lumber Street at the South corner of Lot 3, Block 37 and found it to be about, but not exactly, 1 chain or 66 feet, and because he found that it was not exactly 1 chain is very likely the reason he did not record any width for Lumber Street.

At the Northwest corner of said Lot 3 there is little difference in the surveys (see plat) except as to the line of Jefferson Street.

I agree with Mr. Lang on the line of Jefferson Street at 22nd Street, but come 2¼ inches west of him at 20th Place. I do not think we should differ here.

The North line of 20th Place (or Ward Ct) as occupied, is not parallel to the North line of Lot 3 (see plat) although 20th Place is recorded as 22.52 feet wide at both ends. This fact should be called to the attention of your lawyer that he may advise you of any legal point as to your rights in 20th Place.

SURVEYING INSTRUCTIONS AT THE UNIVERSITY OF ILLINOIS

C. K. MATHEWS
Instructor in Civil Engineering, University of Illinois

Surveying is taught to Civil Engineering students at the University of Illinois during the first and second semesters of the Sophomore year and the first semester of the Junior year. The men come to the courses at the average age of twenty, without having studied any subjects of applied science. The prerequisites for C. E. 27, (the first semester course) are courses in the elements of drafting and plane trigonometry. The men have also had courses in college algebra, Freshman English, analytic geometry and descriptive geometry. At the same time that they study C. E. 27 they are studying calculus and physics. C. E. 27 has, for a foundation, these pure sciences, upon which to build the beginning of the student's work in Civil Engineering, which is made up of applied sciences.

The objects in teaching the courses C. E. 27 and 28 (the second semester course) are three; first to develop in the student the ability to start with a few facts, and, by logical reasoning, to deduce the desired result; second, to impress on him the fundamentals of the care, use, and adjustment of the transit, level and tape; and third, to be able to utilize his field notes in making computations and plans.

C. E. 27 and 28 are both three hour courses, which means that there are about 112 periods, which are each supposed to take 3 hours of the students time, making a maximum of 336 hours, which, if spent as in practice, in 8 hour days would total seven weeks. Most of you have had experience in trying to make an intelligent helper out of a high school graduate and can realize what only seven weeks training would make of such a man in practice. Our working conditions here are, in several respects, not as well suited to instruction in surveying as they would be in practice, because, at the same time that a student's mind is working on surveying, he is being given a rather difficult course in physics and calculus, and what is perhaps more important, surveying is not well adapted to a two hour period, which is the length of a field exercise. Deducting 30 minutes for checking out instruments, going to the field and returning, leaves an hour and a half for the fieldwork, which must be dropped there, to be continued, generally with a loss of time, on returning to the problem two days later. A field surveying summer-camp, such as exists at most large engineering schools, would correct these faults, in addition to giving the men a much better training in manipulation of instruments, with increased value to their employer on graduating.

C. E. 27 is divided into two periods, from the middle of September to Thanksgiving and from then to the end of the semester, so arranged, for the most part, because of weather conditions. No field work is attempted after Thanksgiving in C. E. 27. From Thanksgiving to the end of the semester the time is spent in plotting field notes, making computations, and a study of public land surveying. The text-books used in both C. E. 27 and 28 are "Elementary Surveying" by Breed & Hosmer, Vol. 1, and a field hand-book of surveying.

The field work in C. E. 27 consists, as far as possible, with the time and place limitations, of the surveys necessary for locating, computing the area, and plotting, an irregular shaped tract of land of about three acres area, with its topography, and furnishing it with water and sewer service and cross-sectioning and setting slope stakes for a road. This is done in twelve periods of two hours each. This work consists of two chaining problems, the measurement of horizontal angles about a point directly and by azimuths with check bearings, stadia measurements and vertical angles to topographical points, an azimuth transit tape traverse, a deflection angle transit tape traverse, prolongation of a line by double-sighting, a simple triangulation problem in determining the height of an inaccessible object, bench mark leveling, profile leveling and setting slope stakes.

The office work in C. E. 27 consists of computing the area of the tract of land by D. M. D.'s, plotting it by coordinates and topographic points by protractor and scale, plotting deflection angles by tangents; computation of excavation for the sewer ditch, and of the road excavation by average end areas.

Throughout all of the field-work, emphasis is put on the importance of consistency and the use of only significant figures. Furthermore, the engineering characteristic of getting the desired result with the least expenditure of time and money is developed by a study of the various possible degrees of precision in transit, level, or taping and the methods necessary to obtain them. For instance, in studying the adjustment of the transit or level, the student is required to know the answer to the following questions: (1) What is the adjustment? (2) What is the test? (3) What type of work is affected by the lack of the adjustment? (4) How may the effect of non-adjustment be eliminated in field methods? (5) How is the adjustment of the instrument made? Also, in measuring a horizontal angle with a transit, knowing the allowable error, the student is supposed to be able to figure roughly the allowable error from each source of error. Or, in good ordinary leveling, knowing that experience has shown that he has an allowable error of about ± .05 feet per mile, to figure the allowable error for reading the rod, fraction of a division in centering the bubble, number of inches from vertical plumbing the rod, and discrepancy in feet in balancing B. S. and F. S. distances for each shot of a given length. It has been our experience that most recent graduates, through lack of practical experience, and no definite figures in their minds regarding precision, try to make all measurements as accurate as possible which may be too accurate or not accurate enough for the desired results, which is poor engineering. There is too great a tendency for an engineering student to graduate with the expressions, "a trifle," "carefully," "exactly," "roughly," "slightly," "a little bit," etc., their only means of expressing precision, and with no definite values in their thought. Of course most of this knowledge will become mechanically correct as a man gains experience in his work. As surveying is a study of measurements, it is considered necessary in our courses to discourage this attitude of the student.

C. E. 28, (topographical surveying) is the second semester course. The work here consists of planning and doing the field work necessary to plot large scale topographic maps and in plotting and making computations from them. Weather conditions, and the lack of a summer surveying camp also influence the arrangement of this work. It is impracticable to go to the field until the latter part of the semester.

After a short study of the nature of contours, a problem in the computation of earthwork from contours and the precision involved in this method is given. Then for several periods transit-stadia and plane-table methods of taking topography are discussed.

The engineering problem to be solved in a topographic survey is the planning of the methods to be used in the execution of the work. This demands a knowledge of all that has been taught in C. E. 27, in addition to the detailed knowledge of the characteristics of a topographic map. In connection with this planning of topo-

graphic surveys, we spend three or four periods enlarging on the students knowledge of errors in surveying, using as a text, Professor Rayner's paper on, "The Theory of Errors in Surveying," presented before this Society at its annual meeting in 1922. We take up in this connection the more systematic, mathematical, analysis of the propogation of errors, or the effect upon the result due to the combined effect of errors in each measurement, which is readily seen to be of much importance in planning the field methods for the horizontal control for a topographical map of a given scale and contour interval or in other more precise types of work. Of course this detailed analysis is unnecessary, for ordinary problems of the surveyor who has had so much experience that he knows, without figuring; and yet, doubtless, if a great many men who have made topographic maps and thought them good, would figure a little along this line, the results would show that the accuracy shown by the completed map had not been attained in the field work.

The first problem in making a topographic map in C. E. 28 is the sand-box study, which has been described in detail by Professor Rayner in Eng. News-Record of Nov. 17, 1921. Briefly, the principles are these; a model landscape is formed of clayey sand in a box about 8 ft. x 10 ft. x 1 ft., (representing an area of about 300 acres, relief 100 ft.) with vertical scale exaggerated. The landscape contains a river, a railroad, wagon roads, houses, buildings, and trees. The methods necessary in the planning and execution of a topographic survey for a map of one inch to 100 feet, and a ten foot contour interval, are discussed and data fitting the landscape are given the students for plotting the map. This type of problem serves two purposes, it makes a comparatively practical study which could not be obtained in the field during the early spring because of weather conditions, and it gives to the student a more comprehensive idea of the job as a whole than can be given in the field where his field of view is confined to the area around only one traverse station at a time.

In connection with this map, a study is made of topographic symbols, and an attempt is made to teach some of the principles of cartography, but, because of the limited time, it is impossible to develope good topographic draftsmen.

The rest of the semester is spent in the field and office, making surveys and plotting the data for a topographic map of the Urbana Fair Grounds to a scale of 1 inch to 100 feet and a two foot contour interval. This is done by an azimuth, tape traverse for horizontal control, differential levels for vertical control, and details by stadia-azimuth. The total time spent in the field during the second semester amounts to about twenty hours.

C. E. 51, (railroad surveying), is given the first semester of the Junior year. It is a three hour course, three one-hour periods being spent in recitation and two three-hour periods spent in the field or office, each week.

The field work is governed by weather conditions, which means

finishing by Thanksgiving day. During this time, a reconnaissance is made and preliminary lines are run and topography taken. After plotting and making a paper location, field location is made, cross-sections taken and finally the earthwork is computed and an estimate of cost is made.

The drafting room work consists of track lay-out problems to calculate, and track lay-out and change of location problems to plot to scale. These plotting problems are given as a desirable and necessary substitute for the field work. The text book used is by Pickels and Wiley.

C. E. 30 is a course given in the senior year which is optional to Civil Engineering students. Except for a brief study, sandwiched in between other periods at the end of the work in C. E. 28, this is the only chance a student has for taking a course in astronomical observations. This course is made up of the studies necessary in small scale mapping, such as triangulation, base line measurement, plane table theory, astronomical observations used in surveying, and calculations in geodetic work.

The results expected from teaching these courses are as follows: the student will be slow and poorly skilled in manipulating surveying instruments, but should acquire skill rapidly in practice; he will make mistakes, but not too many; he will have an intelligent conception of the accuracy necessary in any particular problem; he will know, or be able to calculate the field methods necessary for economic solution of the problem; he will know, and his employer should expect him to know, when the work is completed, that the results are accurate within the allowable error. In order to develope this latter characteristic, it is our policy to discuss every field problem before going into the field on the following points: (1) what checks are there? (2) what is the allowable error in each? After this preliminary discussion, it is considered poor for a student to bring a completed field problem to the instructor, and ask, as has been the habit of most students, the questions, "Is this correct?" or "Is this close enough?"

You are the best judges of whether these results are desirable and whether they have been accomplished. You are the employers of these students, and surveying in some form is one of their first jobs. If a student can be made more proficient in this work, he will be on graduation more valuable to you and to himself. We believe that the student will become much more proficient when the University of Illinois gets a summer camp course in surveying.

ORGANIZING FOR CITY PLANNING

Jacob L. Crane, Jr.
City Planning Engineer, Chicago

When interest in city planning became general in this state, about 1920, it was found that additional laws were necessary to make city planning possible. Accordingly, in 1921, two new laws

were passed,—one authorizing zoning and one authorizing general city planning. They were both necessary. Zoning is fundamental, and has to do with outlining the different areas in the city suitable for various types or uses. The City Planning Law made it possible for City Plan Commissions to prepare city plans, and for the city to adopt those plans, and for those plans to control the location of the main highways, parks, and playgrounds, civic centers, grade separation, and so on, within the city and also outside the city for a mile and a half beyond the city limits.

Now we are operating under those two laws. The City Planning Law authorizes City Planning Commissions of any number to be appointed by the mayor, with the approval of the City Council, but requires that the mayor himself and the president of the Board of Local Improvements act as *ex-officio* members of this Commission. Some towns have gone into the work without examining the laws, and have neglected this point, and so the Commissions may be illegal. The Zoning Commission is also appointed by the mayor, with the approval of the city council, and may be of any number. The City Planning Law provides that the two can be combined in one Commission if it is desired. A good many towns have undertaken zoning alone. This is usually, I believe, a mistake. Zoning and city planning should be carried out at the same time, in which case it is desirable to have both branches of the work undertaken by a joint Commission.

The Commission should be small in number. In the ordinary town five, or at most seven, is plenty. It is a mistake to have too many. One town had seventeen members on its Commission, and was rarely able, consequently, to get a quorum together for any official business. Such a situation necessitates an executive committee with power to act. The state laws do not provide for compensation for the members of the Commission, and it is customary to specify in the ordinance establishing the Commission that they serve without compensation. In other words, it is a job for love only. But the citizens engaging in city planning activities usually find that it is about as interesting as anything they can do. It is seldom that a city planning program doesn't arouse enthusiasm and give great satisfaction to those carrying it out. It is important to get good men on these Commissions, since they have on their hands to a fair degree the whole future of the community, and unless they are men of considerable calibre the work is likely to suffer.

The first essential thing is the Civic Survey to determine what the existing conditions are and the controlling tendencies, directions of population growth, possibilities for development of utitlities and transportation,—things which, if this work is to be done soundly, must all be considered. That survey and the preparation of the plans require engineering services, and this means that during the first year or two of a Commission's work, a fund is necessary to finance the engineering work. I have drawn up a statement

of the approximate cost in towns of various sizes. Some towns are afraid to start the work for fear it will cost too much, whereas usually too little is spent on a project so important.

For a town undertaking zoning alone without the general city planning, an arrangement which is occasionally advisable, the following figures will give an idea of the cost of carrying out the zoning program. That program includes the survey, platting, preparation of the plans, preparation of the ordinance, and carrying it through the various hearings. For a town of 1000 people, five hundred dollars; for a town of 10,000 people, about one thousand dollars. The town of 10,000 people is today the typical town that undertakes this work, and the cost runs about ten cents per capita. For a town of 25,000, two thousand dollars would be required, and for a town of 50,000, three thousand dollars. As is apparent, the proportionate cost decreases as the size of the town increases.

A complete civic survey and complete city plan can cost from five hundred to twenty thousand dollars. A report can be made for five hundred dollars, but it will not be much good. To make a sound city plan which can be depended upon for the future, the cost will be about as follows: for a town of 1000 people, about two thousand dollars; ten thousand people, five thousand dollars; 25,000 people, eight thousand dollars; 50,000 people, twelve thousand dollars.

When the city plan has been completed and adopted, there is still work for the City Planning Commission to do in carrying out the projects. If the reports are simply submitted and filed, nothing important will be done with them. Then the money is wasted and the results hoped for will not be secured. The only group that is in a position to take the responsibility for adapting the city plan to changing conditions and for giving it the necessary promotion to secure support is the City Plan Commission. And it will require some funds year after year for this promotional work. Only a small fund is ordinarily needed,—something like five hundred dollars a year in the smaller town, up to four or five thousand dollars or perhaps more in the city of 50,000 people. All of these figures are small when calculated on the per capita basis. In fact, the cost of this work appears insignificant when one considers its importance to the whole future of the community. I want to emphasize the fact that it is a mistake to undertake a city planning program and then under-finance it.

It is usually best for the cost of city planning and zoning work to be paid out of the city treasury,—in most cases out of the general fund. Of course most towns are hard up these days, and in communities where there isn't enough money available in the city treasury, a fund has been raised by popular subscription. Sometimes Chambers of Commerce or groups of citizens finance the work. Whenever it is considered urgent to get the work started, it is all right to pay for it in this way. But usually it is better to

have it financed with city funds, for then it is purely a city project as it should be.

After the completion of the civic survey and the preparation of the city plan, one of the most important items of the program remains to be accomplished. This is the effective presentation of the plan to the people of the city. It is futile to make fine pictures of the future city,—pictures generally involving projects difficult for the general population to imagine,—and to go no further than making the pictures. It takes a good deal of what might be called education, mostly presentation and explanation, to get them firmly placed in the people's minds. That is as much as half the battle.

City planning and zoning are increasing in popularity. As you know, most of the towns around Chicago already have plans completed, and a number of the larger towns down-state are working on them. At this time Illinois is third among the states in the number of town and cities which have undertaken this valuable work.

"THE MAPPING PROGRAM OF THE STATE GEOLOGICAL SURVEY"

M. M. LEIGHTON
Chief Illinois Geological Survey

There was a time when the topographic map was used chiefly by the geologist in his study of mineral deposits and in the mapping of geologic formations. The uses of topographic maps, however, have so increased that our mapping program must now take into consideration many other needs than the geologic needs. It has also become advisable to hasten our topographic mapping program and this has called for a corresponding increase in funds.

The last session of our State Legislature appropriated $50,000 per year for the present biennium. This sum is matched dollar for dollar by the United States Geological Survey which makes available for our mapping in Illinois a total of $100,000 per year for the present biennium. This Society has taken such an interest in the matter of topographic mapping in this State and has played such a valuable part in securing the necessary funds for our program that it is a satisfaction to report to you the accomplishments of the Survey up to the present time.

PRESENT STATUS OF MAPPING

The total amount of territory which has been sketched to date includes 20,750 square miles, or 37 per cent of the whole State. This is exclusive of a few quadrangles which were mapped many years ago according to standards which are now unsatisfactory.

The area which was sketched in 1923 is somewhat in excess of 2500 square miles, or 4.5 per cent of the State. This accomplishment measures well with that accomplished in 1921 and 1922 combined, when a total of 3350 square miles was mapped. This in-

crease in the average rate of mapping is of course due to the funds having been increased from $70,000 per year to $100,000 per year, and it is noteworthy that the increase in results is commensurate with the increase in funds.

In addition to the area noted above as having been sketched, a large amount of primary traversing and primary leveling was done. It appears that we have reached a point now where, in the main, primary traverse may be carried on over large territorial blocks rather than for single quadrangles. This procedure lowers the cost of the work and facilitates the selection of quadrangles to be sketched in case of some emergency.

REQUESTS FOR 1924

Preparatory to formulating a program for 1924 the Geological Survey is in receipt of requests for mapping from various sources. These sources include the Highway Division and the Waterways Division of the Department of Public Works and Buildings, the Sanitary Division of the Department of Public Health, the Water Survey Division and the Natural History Survey Division of the Department of Registration and Education, the departments of Agronomy and Horticulture of the University of Illinois, the Western Society of Engineers, and the Highway Engineer and the Chief Forester of Cook County.

The requests from the Highway Division are for maps of certain rough strips of country which are likely to be involved in the State's road building program in the near future. In the past our topographic maps have saved in many cases preliminary surveys and have facilitated the location of roads with respect to the shortest distance between two points and with respect to the lowest grade and a minimum of cut and fill. The Waterways Division requires topographic maps for an accurate study of the run-off of watersheds and drainage lines. The Water Survey Division and the Sanitary Division are both interested in topographic maps which readily show the area involved in any reservoir project. The request from the Natural History Survey Division is unique in that the study of the insect pests of the apple orchards of Pike and Calhoun counties, which this division is carrying on, has demonstrated that certain physiographic environments govern the habitats of certain insects and a topographic map of this rough country will serve as a valuable guide. Decided advances may be made by the departments of Agronomy and Horticulture of the University if topographic maps of the areas involved are in hand.

With a knowledge of these needs the Geological Survey will endeavor to outline a mapping program to meet them so far as the available funds will permit.

RELATIONS OF THE MAPPING IN ILLINOIS TO FEDERAL APPROPRIATIONS

As has already been mentioned, one-half the amount of money which was spent in our State the past year was allotted by the

United States Geological Survey in coöperative work with our State Geological Survey. The appropriation of the State Geological Survey is for the biennium, but the appropriations made by Congress are for one year only. There is before Congress at the present time the Appropriation Bill of the Department of the Interior which includes the budget items of the United States Geological Survey for topographic mapping, and which requests a reappropriation of the same amount as was granted last year by the Temple Bill. Any cut which would be made in the request of the United States Geological Survey, therefore, would handicap them in meeting the needs of the various states including our own. Inasmuch as the recent increase in appropriations has stimulated a mapping program commensurate with our needs you will observe that it would be an extremely serious matter to have such a program curtailed. Your cognizance of this situation in your present session, with recommendations to our Congressmen would unquestionably be of great value.

REMARKS

Mr. Randolph:—I should like to have Mr. Leighton explain the program for the topographic mapping around Chicago and the coöperation with the United States Geological Survey.

Mr. Leighton:—I am very much obliged to Mr. Randolph for reminding me of this matter which I intended to bring before the Society. We have, as a part of our program for the coming year, the revision of the old maps of Chicago and vicinity which were made so long ago that their standards of mapping will not meet the present engineering needs. The contouring is quite too generalized and the culture is very much out of date. The maps fail to show the lines of growth of Chicago as they actually exist today. You may be interested to know that the Board of Direction of the Western Society of Engineers unanimously approved the consideration of the remapping of this territory by the Illinois Geological Survey in coöperation with the United States Geological Survey and has urged that a revised map be made. An agreement has now been reached for this resurvey and at the present time preliminary data are being obtained from the offices of the City Engineer of Chicago and of the Chief Engineer of the Sanitary District, and from other sources. We hope that with this accumulation of preliminary data a vigorous field program may be executed the coming summer and the work be expedited.

The map which we have in mind is to be on a larger scale than the last. The State will publish a map which will be on a scale of approximately 2½ inches to the mile instead of one inch to the mile, and the contour interval will be five feet instead of ten. In all respects the map will measure up to modern standards.

Mr. Randolph:—Did you consider in this work securing photographs made by the Air Service, or have you anticipated that?

Mr. Leighton:—I may say that we have received an expression of willingness on the part of the Air Service of the United States

Army to coöperate with us in this mapping by furnishing the United States Geological Survey aerial photographs of the area. Inasmuch as these will show the culture, drainage, and forested areas the work will not only be expedited but will be done at less cost.

SHOOTING OF WELLS

BY C. W. VARNER
Well Contractor, Dubuque, Iowa

In the shooting of wells to increase the amount of water they will produce, the first consideration is the rock formation. The usual rock formations in Illinois and neighboring states are Trenton, Galena and Magnesia limes, shales, St. Peter and Potsdam sandstones. On account of the solid formation of limestones, any water coming from them must come from the seams or crevices in them.

Sandstone is very different in this respect. It is composed of a conglomeration of fine or coarse sand particles welded together by lime and silica particles and chemical action. Its water producing qualities depend principally on the coarseness of these sand particles. Where these sand particles are very fine and have a deposit of clay running through them, they do not produce very much water.

The wells that it is most advisable to shoot are those of the St. Peter or Potsdam sandstone. In the shooting of sandstone formation the rock breaks into fine particles and in the case of a flowing well the particles of broken rock usually flow out with the water. If not, they can be bailed out with an ordinary bailer or sand pump. Limestone, on the contrary, breaks into such coarse material that there is danger of closing up the well entirely. Of course, this material could be broken up with a set of drill tools, but the hole would be in a shattered condition and liable to close up again. The benefits to be obtained in shooting a limestone well are not apt to be very great.

According to my experience, the corrosion is the main trouble that makes it necessary to shoot the wells to increase the yield. In my estimation, this corrosion is caused by chemical action from the chemicals that are in the water itself, such as sulphate of lime, bicarbonate of iron and magnesia as well as some chloride of lime. On account of the nature of the sandstone it is very possible for these chemicals to form a coating similar to rust on the walls of the well, closing off the pores from the sandstone itself and consequently stopping the flow of water. Where the sandstone contains considerable clay it can be helped by shooting, that is, its water producing qualities can be increased, as it breaks the sandstone back some distance and creates more surface for the water to come through in much the same way as in oil sands of oil wells.

I think that in the shooting of wells each well should be considered in a part by itself, as there are many things to take into consideration—the depth of the sandstone, the fineness of the sandstone, the thickness of the strata, and the amount of water or the amount of head of water over the strata to be shot. Fine, hard sandstone may be shot much harder than softer sandstone. If soft sandstone is shot too hard some trouble may be encountered with the pumps cutting out from the continual flow of this sand; sometimes for considerable time after the shot has been put in.

In cases where the well to be shot has a head of water over the sand stratum of ten to fifteen hundred feet or more, usually they may be shot with a larger charge than the wells where the amount of water over the stratum is not so great, say, eight hundred feet or less. In the lesser depths dynamite may be used successfully. In the greater depths the explosive must be a good quality, and usually special cartridges must be used in order to have any success. I think this one thing has caused more discouragement in the shooting of wells than any other one thing, as the charges do not do good work under great depths of water unless great care has been taken in making up the cartridges, and the quality of explosives used, as a great quantity of explosives may not do any good if it is not used under good conditions.

Often in my experience in the shooting of wells in the last fifteen years, I have learned many things that I found to be useful in this business. In several instances in the last seven years I have shot what formerly were flowing wells that had not flowed from ten to fifteen years. There were three wells for the City of Dubuque that I shot, one drilled in 1888, one in 1898, and one in 1900. The one drilled in 1888, and also the one drilled in 1898, had not flowed for several years. By shooting them the heads of these wells were brought back to twenty-eight and thirty feet above the surface, producing a flow of from 250 to 275 gallons per minute. One well shot for the Dubuque Packing Company in 1918 had not flowed for ten years or more. This was brought back to a normal flow of approximately 200 gallons per minute. In an artesian well for the Tri-State Milk Producing Company at Galena, Illinois, the flow was brought from practically nothing to approximately 250 gallons per minute. Part of this was due, of course, to a hole in the pipe, but the main increase in the amount of water was from the shooting of the sandstone. I have found that it is much better to shoot the sandstone in several places, from forty to fifty feet apart, depending on conditions as already mentioned, such as the fineness and hardness and also the amount of clay in the sandstone.

THE ESTABLISHMENT OF ENGINEERING STANDARDS FOR MUNICIPAL FIRE-FIGHTING FACILITIES

CLARENCE GOLDSMITH,
Asst. Chief Engineer, The National Board of Fire Underwriters

The general subject of standardization has been receiving the attention which it merits in recent years, having attained a considerable impetus during the World War. The establishment of the major portion of standards devolves directly or indirectly on the engineer as he by training and experience possesses the knowledge to develop them, and he naturally approaches the innumerable problems involved with enthusiasm, as none other can appreciate the value of standardization from the standpoint of economy and efficiency as fully as he.

It has only been during the past score of years that the problems involved in connection with municipal fire-fighting facilities have received any considerable attention from engineers. A Committee on Fire Prevention had been maintained by The National Board of Fire Underwriters since 1892, but its activities were small in scope. The functions of this committee were delegated to the "Committee of Twenty" under the direction of which an engineering corps was organized, and investigations of the fire-fighting facilities of a number of the larger cities in the country were made.

In 1912 nearly 200 cities had been investigated and reports had been prepared. The considerable data then collected appeared to be sufficient to warrant starting the formulation of standards, and the work was continued for the ensuing four years, use being made of supplementary data gathered from about 100 additional cities inspected during this period, as well as data collected by rating bureaus in smaller cities and towns. The "Standard Schedule for Grading Cities and Towns of the United States with Reference to their Fire Defenses and Physical Conditions" was published in 1916. This schedule is based on and contains the standards determined upon. There are 129 distinct items considered, and each item involves one or more standard requirements. Up to the year 1923 the schedule had been applied to 4,534 cities, those having populations in excess of 20,000 being graded by engineers of the National Board, and the smaller cities and towns by engineers of the several rating bureaus. It was found desirable to make a few minor modifications in the standards originally established, partly due to the advance in the art of fire protection, and partly due to additional information obtained by the general application of the schedule, and therefore a new edition was issued in 1923.

Some of the more important standards for fire protection will now be discussed. In order that a water system may be adequate, it must be able to deliver the full required fire flow, in addition to the maximum 24-hour domestic consumption rate, into any area

being considered. The fire flow required in the principal mercantile district of any city is determined by the formula

$$G = 1{,}020 \sqrt{P}\ (1 - .01 \sqrt{P})$$

where G = gallons per minute and P = population in thousands. This quantity provides for probable loss from broken connections incident to a large fire. The formula was prepared after a very careful study by the engineers of the National Board. It was first presented before the American Water Works Association by Metcalf, Kuichling and Hawley, who carefully reviewed the figures and compared them with other authorities. The quantity required by the formula is that considered necessary for a very severe block fire or two simultaneous fires of considerable magnitude. It is not considered that this capacity will be sufficient to furnish all the water used and wasted during a conflagration involving a large part of the business district. It is true that the fire flow required is dependent upon the structural conditions, but on account of the similitude of structural conditions in practically all American cities, it has been found that more satisfactory results are obtained by basing the fire flow on the population.

Attention is called to the fact that maximum daily consumption is used in determining the adequacy of a system and not the maximum hourly rate.

In order that a water system may be normally adequate in capacity, in accordance with the standard, the source of supply, intake, suction lines, low-lift pumps, compressors, high-lift pumps, boilers, stacks, filters, and supply mains must each, in such combination as they may occur, be of sufficient capacity to maintain the required rate over a 10-hour period.

The standard of reliability for number and capacity of pumps is that with the two largest pumps out of service, the remaining pump capacity shall be such as to maintain maximum daily consumption and fire flow at required pressure. The adequacy of pump capacity may be dependent upon high-lift and low-lift pumps, compressors, electric generators, or other separate and distinct units; each group performing a given function must be considered separately.

In order that the reliability of supply mains as affecting adequacy may be standard, a single break in the suction or gravity lines to pumping stations, flow lines from reservoirs, force mains, and main arteries must not reduce the available supply below the rate required to furnish maximum domestic consumption and fire flow at the required pressure.

The standard for valve spacing requires that supply mains be cross-connected and gated about once a mile, the larger arterial mains of the distribution system be gated so that not more than one-fourth mile will be affected by a break, and the other mains in the distribution system be equipped with a sufficient number of gate valves so located that no single case of accident, breakage or repair to the pipe system will necessitate the shutting from service

a length of pipe greater than 500 feet in high value districts, or greater than 800 feet in other sections.

The number of hydrants required is dependent on the fire flow required, and the standard established is that they shall be so spaced that two-thirds of the fire flow can be concentrated on any block or group of buildings through hose lines, none exceeding 600 feet in length for pumper supply and 500 feet in length for direct hydrant hose streams. This requires the following hydrant distribution:

Fire Flow Required Gallons per Minute	Average Area per Hydrant Square Feet
ENGINE STREAMS	
1,000	120,000
3,000	100,000
5,000	85,000
7,000	70,000
10,000	48,000
12,000	40,000
DIRECT HYDRANT STREAMS	
1,000	100,000
2,500	78,000
5,000 and over	40,000

Hydrants to comply with the general standard established for municipal service shall be able to deliver 600 gallons per minute, with a loss of not more than 2½ pounds in the hydrant and a total loss of not more than 5 pounds between the street main and outlet; they shall have not less than two 2½-inch outlets and also a large suction connection where engine service is necessary. They shall be of such design that when the barrel is broken off the hydrant will remain closed. Street connections shall be not less than 6 inches in diameter and shall be gated. Hose threads on outlets should conform to the National Standard.

The foregoing are five of the thirty-one standards established for water systems. A few of the more important fire department standards will now be considered.

The number of automobile engines and hose companies required in any city is determined by the formula $0.85 + 0.12$ P, where P is the population in thousands, in cities having less than 50,000 population, and formula $3.4 + 0.07$ P in cities having populations of 50,000 to 200,000. This provides a sufficient number of companies so that one is within three quarters of a mile of every point in mercantile and manufacturing districts and within a mile and a half of any point in closely built residential areas. In some cities an excess of the above will be required, depending on the structural conditions found. Also the topography and general layout of some cities may require additional companies, for proper distribution.

The number of automobile ladder companies required is determined by the formula $1 + 0.03$ P in cities having populations from 20,000 to 200,000, and in larger cities, the number will be determined by the required distribution which should be such as to pro-

vide a company within one mile of every point in mercantile and manufacturing districts, within two miles of every point in closely built residential districts, and within three miles in scattered residential sections. An aerial ladder must be provided in a district where five buildings are four stories or higher, and one ladder truck in five shall be aerial.

Standards are also established for the number of reserve pieces of apparatus which should be provided to keep the existing fire companies in service. One reserve pumper should be provided for each eight engine companies or major fraction thereof required; one reserve hose wagon for each twelve hose companies or fraction thereof required, and one ladder truck for five or fraction thereof required.

The standard for the strength of companies is as follows:

COMPANIES	Least Number of Men on Duty Daytime	Nighttime
Within or near any High Value District:		
Engine Company	7	9
Ladder Company	7	9
Hose Company	5	7
Water Tower Company	1	1
In Other Districts:		
Engine Company	5	7
Ladder Company	5	7
Hose Company	3	5

In the above table the strength of engine companies is based on steam fire engines; one man less may be allowed in companies having automobile pumping engines, and the minimum may be decreased by one man in ladder companies having quick-raising aerial ladders. Four call men or eight volunteers are considered equivalent to one full-paid man, but only up to one-third the least number of men required to be on duty at all times. Credit is given for the men of the off-shift platoon for the number which the department records show respond on call in the same manner as for call men. These standards for manning are in general accordance with the ideas of the fire chiefs of the larger cities.

The standard for apparatus equipped with large chemical tanks, i. e. tanks having capacity of 35 gallons or more, is that sufficient number of pieces of apparatus be equipped with these tanks so that at least two pieces so equipped shall respond to each first alarm.

In order that sufficient large hose may be provided with a capacity adequate to develop the required streams and provide for a sufficient quantity so that enough serviceable hose may always be available, the following standards have been established: Each engine or hose company shall carry at least 1,000 feet of 2½ inch or larger hose, and shall be provided with a complete spare shift; hose companies responding to first and second alarms in mercantile or manufacturing districts, where direct hydrant hose streams are used, shall carry at least 500 feet of 2¾-inch or 3-inch hose, the remainder being 2½-inch; engine companies and hose companies

in other districts shall carry at least 200 feet of 2¾-inch or 3-inch hose, and the remainder of the 1,000 feet should be 2½ inch; and one or more of the reserve hose wagons shall be loaded with at least 1,000 feet of 3-inch hose.

Under the heading of fire department, thirty-three standards in all have been established, and in addition to those just described, some of the more important deal with the qualifications and appointment of officers and men, and provisions for their retirement; number of powerful stream appliances needed; the minor equipment which should be carried upon each piece of apparatus; methods of handling fuel; regulations for the enforcement of discipline; the assignment of apparatus for response to alarms; methods of drill and training; and provisions for making building inspections.

In connection with the fire alarm system, one of the most important standards is that the fire alarm headquarters building be of fireproof construction, contain no combustible material, and be unexposed or provided with ample and reliable protection against exposure.

The standards for headquarters equipment are that any system handling more than four hundred alarms a year shall have provision for transmitting alarms manually, the automatic method of transmission being satisfactory for smaller systems. An automatic system shall have a repeating mechanism, manual transmitting apparatus, switchboard, repeater, and cable terminal. A manual system shall have receiving apparatus, transmitting apparatus, recording apparatus, control board, testing facilities, and cable terminal.

The standard for circuits is that they be underground, the wire to be not less than No. 12 gage for a single conductor, or less than No. 14 gage for two or three conductors, and No. 16 gage for four or more conductors. Wires shall have rubber insulation and shall be protected by lead sheath. Inasmuch as it is impracticable to install the entire circuit mileage of any system underground, standards have been established for overhead wiring. Aerial wires shall be not less than No. 10 gage copper, or No. 12 gage copper-clad steel with double or triple-braid weather-proof insulation.

The standards covering fire alarm boxes are as follows: That not more than twenty boxes shall be dependent on any box circuit; boxes shall be non-interfering and succession; boxes shall be so located that one will be within at least 500 feet of every building in mercantile and manufacturing districts, and 800 feet of every important group of buildings elsewhere; boxes in high value districts shall be indicated by red lights at night, and boxes in other districts shall have a distinguishing band painted on the supporting pole; all boxes shall be painted red as often as needed; and boxes shall be timed so that the alarm will be transmitted at a speed of not less than one stroke per second.

The transmission of alarms of fire by telephone can in no way be considered as satisfactory as their transmission over a fire alarm telegraph system; however, owing to the wide distribution of telephones, a considerable portion of alarms are being received by means of telephones in nearly every city. Standard means shall be provided for handling these alarms so that undue delay and mistakes may be reduced to a minimum.

The standards for building construction are contained in the Building Code Recommended by The National Board of Fire Underwriters. This code was developed and is kept up to date by the Committee of Construction of Buildings of the National Board of Fire Underwriters, which employs a consulting engineer and a staff for this purpose. The code prescribes standard limitations for heights and areas, protection to exposed windows, protection to vertical openings, protection to communications through fire walls; prohibits frame construction within fire limits; and gives standards for wall thicknesses, construction of chimneys and heating apparatus, improved construction, private fire protection, construction of fire stops, fire escapes, parapets, and the quality of materials and workmanship. The code has been adopted by a number of cities and is widely used by architects and engineers as a guide in design and construction.

All large cities now have comprehensive laws governing the hazards. The National Electric Code, prepared and sponsored by engineering societies, insurance organizations, and manufacturers of electrical equipment, and generating companies, is universally adopted as the standard for electrical construction. Engineering representatives of The National Board of Fire Underwriters are members of the committee which prepares the code.

The National Board publishes regulations covering the various hazards. These regulations are prepared and kept up to date by committees of the National Fire Protection Association. These committees are composed of insurance engineers and representatives of the manufacturers and distributors of the various materials considered. The more important of these regulations comprise those covering oil lighting and heating, gas lighting and heating, inflammable liquids, hazardous chemicals, carbide, garages, dry-cleaning, nitro-cellulose and films, motion picture machines and booths, explosives, fireworks, matches, combustible fibres, lumber and packing materials, and rubbish, trash, ashes, bonfires, etc.

The National Board of Fire Underwriters is an educational, engineering, statistical, and public service organization maintained by the stock fire insurance companies. To all intents and purposes it is a public service institution in most of its actitvities. Its engineering organization is available for consultation upon request of civic authorities, civic organizations, and consulting engineers. Application for such service or for copies of the rules and regu-

lations and fire prevention literature may be made at the principal office or either of the branch offices.

DISCUSSION

Dr. Buswell: I would like to ask Mr. Goldsmith whether any chemical qualities of the water in the different cities have been considered. In some cases it makes considerable difference.

Mr. Goldsmith: We do not go into the question of the chemical composition of the water, its analysis or its corrosive possibilities. The only thing that governs our classification of the city is the result of the fire flow tests, and we frequently recommend the cleaning of large mains when we find the coefficient has dropped low. I should like to say in this connection that we are probably more or less misunderstood by many engineers, particularly those interested in the purification of water, who believe that the fire insurance interests are not concerned with the purifications of supplies. Never, during my connection with The National Board have we ever recommended the use of a polluted supply where it might become available for domestic use.

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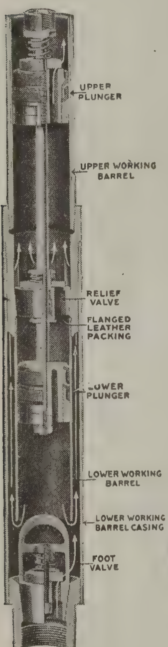
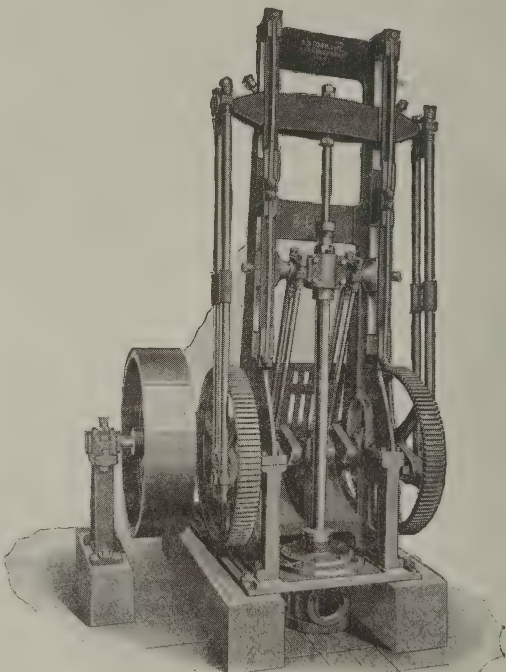


FIG. 950 B



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